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Scientific and Technical Aerospace Reports

A SEMIMONTHLY ABSTRACT JOURNAL WITH INDEXES

NOVEMBER 23, 1965

VOLUME 3 • NUMBER 22

N65-33550—N65-34724

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Scientific and Technical Aerospace Reports, Volume 3, is prepared by the Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by Documentation Incorporated.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget January 9, 1965

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VOLUME 3 NUMBER 22

Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

November 23, 1965

01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N65-33558 St. Louis Univ., Mo. Inst. of Technology.
THE DETECTION OF GENERATING EDDIES IN CLEAR-AIR TURBULENCE ALOFT BY ACOUSTICAL SENSING
F. C. Bates *In* Mich Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 95-103 (See N65-33550 22-13)

Proceeding from the findings of many studies of microbarovariations and a simple model of eddy generation in clear-air turbulence (CAT) aloft, the hypothesis that generating eddies in such turbulence cause the microbarovariations is offered. Estimates of amplitude and frequency based upon the model and typical values for a turbulent layer at 10 km are made and found to compare favorably with those sensed by the Macelwane microbarovariograph. Potential application of the consequent acoustical remote-sensing technique in the detection, mapping, tracking and prognosis of CAT loft is outlined. Testing of the hypothesis and development of improved and field instruments remain to be accomplished. Author

N65-33605* ARO, Inc., Arnold Air Force Station, Tenn. von Karman Gas Dynamics Facility.
HYPERSONIC FLIGHT SIMULATION: AERODYNAMICS
J. Leith Potter *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. B [1964] 60 p refs (See N65-33604 22-30) CFSTI: HC $6.00/MF $1.50

Laboratory simulation of the aerodynamics of full-scale hypersonic flight are considered, and some questions arising from extending scale-model data to full-scale systems are noted. Real-gas effects in aerodynamic simulation are mentioned in connection with problems related to creating the necessary flow fields in the laboratory. A discussion of the simulation of rarefied flow fields deals with real-gas and nonequilibrium effect including heat transfer rate and pressure. Problems in low density flow are considered in terms of thermomolecular flow in tubes, surface interaction, orifice effect, nozzle design, and pumping systems. Results with a low density hypersonic tunnel are presented under the headings of heat transfer, drag, shock waves, three component measurements, and viscous interaction. Simulations of conditions of high Reynolds numbers and planetary atmospheres are discussed. The simulation facilities considered include continuous or intermittent-type, impulse-type high enthalpy, and low density hypersonic wind tunnels; and an aeroballistic range and counterflow facility. M.W.R.

N65-33674# Texas Univ., Austin. Defense Research Lab.
MEASUREMENTS OF DRAG ON SINGLE AND TANDEM CYLINDERS MOUNTED ON A FLAT PLATE IN MACH NUMBER 5.0 FLOW
J. C. Westkaemper 23 Aug. 1965 36 p refs
(DRL-531; CR-20)

Direct measurements of the drag of right-circular cylinders were made with the cylinders mounted perpendicular to a flat plate. The drag was measured by a modified floating-element type balance. All cylinders were 0.6 in. in diameter, with lengths ranging from 1/32 to 1-1/2 inches. The boundary layer at the test station was turbulent and approximately 1/4-in. thick. The testing was done in a Mach 5 wind tunnel. Data were obtained with single cylinders as well as with pairs of equal-length cylinders mounted at various spacings and aligned in the flow direction. The resulting drag coefficients are intended to aid in estimating the drag of surface protuberances such as rivets, bolts, and probes. A limited number of cylinder stagnation-line pressure measurements were also made to study the nature of the flow around such protuberances. Author

N65-33834*# Pratt and Whitney Aircraft, East Hartford, Conn.
INLET-TO-INLET SHOCK INTERFERENCE TESTS Final Report
D. L. Motycka and J. B. Murphy Washington, NASA, Sep. 1965 54 p refs
(Contract NAS2-2079)
(NASA-CR-264) CFSTI: HC $3.00/MF $0.50 CSCL 01A

As flight speeds increase, supersonic aircraft powerplant installations may encounter complex aerodynamic problems due to shock reflection and the possibility of inlet shock instability created by pod-to-pod interference. This report describes the experimental program conducted and presents wind tunnel test data obtained during a comprehensive study of adjacent inlet interference. This test program established, for a typical Mach 3.0 design mixed compression inlet, the dividing line between the regions of expelled shock interference and completely stable operation. A study was also conducted to determine the effect of placing a plate between pods. Author

N65-33836*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF REARWARD BODY STRAKES ON THE TRANSONIC AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT-WING FIGHTER AIRCRAFT

C. Robert Carter Washington, NASA, Sep. 1965 39 p refs (NASA-TN-D-3011) CFSTI: HC $2.00/MF $0.50 CSCL 01A

An investigation has been conducted in the Langley 8-foot transonic pressure tunnel to determine the effects of two rearward body strakes on the aerodynamic characteristics of an unswept-wing fighter aircraft through high angles of attack. The tests were conducted at Mach numbers from 0.50 to 1.03 and angles of attack from approximately 2° to 26° at angles of sideslip of 0°, 3°, and 6°. The results of this investigation indicate that the addition of the two rearward body strakes had little effect on the aerodynamic characteristics. Specifically, the "pitch-up" lift coefficient (lift coefficient at which longitudinal instability occurs) was increased only slightly by the addition of the strakes. Also, in the region of the pitch-up lift coefficient, only very small increases in the lateral stability parameters occurred. Author

N65-33839*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

EVALUATION OF THE LATERAL-DIRECTIONAL STABILITY AND CONTROL CHARACTERISTICS OF THE LIGHTWEIGHT M2-F1 LIFTING BODY AT LOW SPEEDS

Harriet J. Smith Washington, NASA, Sep. 1965 36 p refs (NASA-TN-D-3022) CFSTI: HC $2.00/MF $0.50 CSCL 01A

The lateral-directional stability and control characteristics of the lightweight M2-F1 lifting body were investigated during glide flights. Prior to flight testing, full-scale wind-tunnel data were used in both analytical and simulator studies to predict the handling qualities of the vehicle. For the glide tests, the vehicle was towed by a C-47 airplane to an altitude of approximately 12,000 feet (3,658 meters) and released. Sideslips, rudder-fixed aileron rolls, and aileron and rudder pulses were performed during the glides over a range of angle of attack from −3° to 13° (−0.05 to 0.22 rad) and at velocities from 77 knots to 119 knots (38.6 to 61.2 meters/second). The M2-F1 configuration tested was found to be sluggish in roll as a result of the combination of high dihedral effect and adverse yaw produced by the ailerons. The high dihedral effect also caused the vehicle to be extremely sensitive to gusts. For the limited mission utilization of a reentry vehicle, the pilots considered the handling qualities of the vehicle to be adequate. Author

N65-33842*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Hampton, Va.

AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THE MOTION OF A ROTATING SPACE STATION

William M. Piland Washington, NASA, Sep. 1965 38 p refs (NASA-TN-D-2981) CFSTI: HC $2.00/MF $0.50 CSCL 01A

An approximate solution to the equations of motion for a spinning body in space was developed using small angle theory to analyze the effects of various disturbances on the body. Results for the approximate solution are compared with experimental data obtained from a space station model subjected to simulated disturbances and with the results obtained from an exact computer solution. These comparisons show that extremely good correlation is obtainable between the approximate solution and the exact solution. In addition, the results of both analytical solutions were verified by the results of tests performed on the dynamic model. The closed form solution developed in this study may be used to investigate the effects of both station body characteristics and disturbance parameters on the resulting body motion. These investigations will yield reasonable results for small body angles and rates. R.N.A.

N65-33882*# Midwest Applied Science Corp., Lafayette, Ind.

ON THE DIRECT SHOCK WAVE PROBLEM. A MODIFIED THEORY (FINAL REPORT ON BODIES WITH SPHERICAL NOSE)

S. S. Shu and David T. Shaw Mar. 1963 38 p refs *Its* Rept. 63-1

(Contract NAS8-514)

(NASA-CR-64923) CFSTI: HC $2.00/MF $0.50 CSCL 01A

The method of attack for the general body problem was modified in order to investigate the direct shock wave problem. The analytical results of the modified problem are presented, and all notations used in the calculations are designated. The calculation of the entropy as a function of Ψ based on the shock shape, is given, and exact relations are derived. Equations are presented for matching conditions, and the sonic point and line are computed as a test of the theory. The theory establishes exact relations between the derivatives of flow velocity components and shock wave parameters. Curves are presented depicting the shock detachment distance versus the free stream Mach number, ($\gamma = 1.4$); the pressure distribution on a sphere ($\gamma = 1.4$), the stagnation-point velocity gradient, α^* versus Mach number; the angular location of sonic point on the body ($\gamma = 1.4$); and the sonic line on a sphere for several Mach numbers. L.S.

N65-33957*# National Aeronautics and Space Administration, Washington, D. C.

SURVEY OF THE NUMERICAL SOLUTION TECHNIQUES FOR VARIATIONAL PROBLEMS IN THE DYNAMICS OF FLIGHT [OBZOR METODOV CHISLENNOGO RESHENIYA VARIATSIONNYKH ZADACH DINAMIKI POLETA]

V. K. Isayev and V. V. Sonin May 1965 23 p refs Transl. into ENGLISH from a paper presented at the 2d Ann. Conf. of the Am. Astronautical Soc., Chicago, 4–7 May 1965 (NASA-TT-F-9543) CFSTI: HC $1.00/MF $0.50 CSCL 01A

Indirect methods of numerical solution of variational problems in rocket flight are reviewed, covering all Russian literature data. Local methods of continuous search are discussed, including a modified version of Newton's method, variants of the steepest descent method, solutions of variational problems with a free right end of the trajectory. Comparisons of the various methods are given, including the example of asymmetric flight to Mars with return, resulting in a 20% advantage over symmetrical flight. A minimum value N_{min} is derived at which the flight will be accomplished at maximum thrust. Author

N65-33999# Technion Research and Development Foundation, Ltd., Haifa (Israel).

APPLICATIONS OF A HIGH-FREQUENCY AERODYNAMIC THEORY TO THE CALCULATION OF FLUTTER AT SUPERSONIC SPEEDS Final Report

M. Hanin and E. Nissim 31 Dec. 1964 58 p refs

(Grant AF-EOAR-63-66)

(TAE-36; AFOSR-65-1008; AD-617931) CFSTI: HC $3.00/MF $0.50

Flutter of airfoil sections in bending, torsion, and control-surface rotation at supersonic flight speeds is analysed by employing an aerodynamic solution for high-frequency oscillations. The analysis includes effects of airfoil thickness and shape, and is valid at arbitrary supersonic Mach numbers and sufficiently high values of frequency variable. For flutter problems with two degrees of freedom (bending-torsion, bending-aileron, torsion-aileron) explicit expressions for calculating the flutter speed and frequency are obtained. The case of three degrees of freedom (bending-torsion-aileron

flutter) is studied by solving the determinant equation numerically. Some calculated results are presented, showing the variation of flutter boundaries with the elastic and inertial properties of the airfoil, the flight conditions and the airfoil thickness. Author

N65-34203# Toronto Univ. (Ontario). Inst. for Aerospace Studies.

EXPERIMENTAL INVESTIGATION OF THE CHARACTERISTICS OF FLOW ABOUT CURVED CIRCULAR CYLINDERS

Jean Surry Apr. 1965 64 p refs
(Grants NRC A-1894; AF-AFOSR-222-64)
(UTIAS-TN-89)

The flow and the associated forces on curved circular cylinders, at Reynolds numbers between 10^4 and 10^6, were investigated. The shape and normal force distribution of a flexible curved cylinder were found. Flow visualisation tests and pressure surveys were made on rigid curved cylinders. A comparison was made with earlier results for infinite straight cylinders inclined to the flow. It is concluded that the curvature of a cylinder has a significant effect on the flow and pressure in the wake, and must be considered in the prediction of the aerodynamic forces on such a cylinder. Author

N65-34222*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF WING PLANFORM MODIFICATION ON LONGITUDINAL CHARACTERISTICS OF A VARIABLE-SWEEP M WING

Edward J. Ray and William P. Henderson Washington, NASA, Oct. 1965 28 p refs
(NASA-TN-D-3025) CFSTI: HC $2.00/MF $0.50 CSCL 01A

An investigation was conducted in the Langley high-speed 7- by 10-foot tunnel to determine the effects of wing planform modifications on the longitudinal aerodynamic characteristics of a variable-sweep wing having an M planform. The test planforms were investigated in combination with a basic-fuselage–vertical tail configuration, without engine packs or horizontal tail. The results indicated that increases in the aspect ratio and taper of the basic planform, accomplished by removing portions of the trailing edge of the outer wing panel, resulted in slight decreases in the variation of the longitudinal stability level with leading-edge sweep angle. The low-lift pitch-up tendencies of the basic planform, however, were aggravated by the modifications to the trailing edge of the outer wing panel. Modifications which were made to the basic planform by removing portions of the wing tip resulted in substantial reductions in the variation of longitudinal stability level with wing sweep. In addition, the wing-tip modifications considerably improved the variation of pitching-moment coefficient with lift coefficient at all leading-edge sweep angles. Author

N65-34254# Advisory Group for Aeronautical Research and Development, Paris (France).

THE APPLICATION OF LOCAL UNSTEADY PRESSURE MEASUREMENTS IN OBTAINING AERODYNAMIC DERIVATIVES

R. Destuynder and H. Bergh Oct. 1964 39 p refs In ENGLISH and FRENCH Presented at the 19th Meeting of the Struct. and Mater. Panel, Paris, 12–19 Oct. 1964
(AGARD-498) CFSTI: HC $2.00/MF $0.50

A half-theoretical half-experimental method of determination of unsteady pressures in subsonic conditions on three-dimensional profiles has been worked out. The purpose is to estimate from various measures of pressure on a wing under subsonic flow conditions the pressure distribution over the whole wing, then to deduce from this the unsteady aerodynamic forces corresponding to a given wing motion. It is achieved by using a mathematical mould which can be adjusted by empirical factors. A brief description of the equipment is given and several applications of the method are commented upon. Author

N65-34297# Pennsylvania State Univ., University Park. Dept. of Aeronautical Engineering.

THE STRUCTURE OF TRAILING VORTEX SYSTEMS BEHIND LIFTING SURFACES Semiannual Progress Report, Oct. 1, 1964–Mar. 31, 1965

7 Apr. 1965 3 p
(Contract DA-31-124-ARO(D)-149)
(AD-464657)

Wind tunnel tests wih a one-tenth scale L-19 wing were conducted at distances of 4 to 14 chord lengths downstream in order to observe the vortex behavior. Instead of a gradual decay in peak vorticity with increasing downstream distance, a radical change in vorticity was observed. In less than a chord length, the form suddenly changed from an exponential shape to one having a pronounced dip in the middle. At further distances downstream, a negative rotation was measured at the center of the vortex. Further investigation of the phenomenon showed that the downstream distance where this sudden change occurred increased approximately inversely with the square of the velocity. This change in vorticity distribution through the vortex may be related to the so-called vortex breakdown phenomenon observed heretofore only with delta wings. J.M.D.

N65-34403*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

A GENERALIZED APPROACH TO DYNAMIC-STABILITY FLIGHT ANALYSIS

Peter Jaffe 1 Jul. 1965 15 p refs
(Contract NAS7-100)
(NASA-CR-67112; JPL-TR-32-757) CFSTI: HC $1.00/MF $0.50 CSCL 01A

A general approach to the analysis of planar flight dynamic-stability investigations is presented and examples are used to discuss the approach. The foundation of the approach is the energy-integral equation which relates the energy defect during a half cycle, due to the decay, to those factors causing the decay. The equation can accommodate nonlinear aerodynamics, large oscillatory amplitudes, nonsymmetric or lifting bodies, and non-continuous or double-valued aerodynamic coefficients. Examples are presented demonstrating these applications. In addition, this report also suggests that the usual closed-form differential solution may not be properly representing all physical mechanisms producing decay because of the continuous nature of its formulation. Author

N65-34525# Rice Univ., Houston, Tex.

OPTIMUM SLENDER BODIES IN FREE-MOLECULAR FLOW

Angelo Miele and Robert E. Pritchard 1965 19 p refs Submitted for Publication
(Grant AF-AFOSR-828-65)
(AAR-7; AD-468764)

The aerodynamic forces exerted by a free-molecular flow were determined for a body of revolution having minimum drag

for a given length and a given diameter. Throughout the analysis, the aerodynamic drag is calculated under the following hypotheses: (1) the mean free path is so large that the incoming and reflecting molecular flows are transparent to each other; (2) the coefficient of absorption is one; (3) the coefficient of thermal accommodation is one; and (4) the velocity distributions of the incident flow and the reflected flow are Maxwellian. The hypersonic approximation, as well as the slender body approximation are utilized. G.G.

N65-34526# Rice Univ., Houston, Tex.
OPTIMUM TRANSVERSAL CONTOUR OF A NONLIFTING BODY IN NEWTONIAN FLOW
Angelo Miele 1965 16 p refs
(Grant AF-AFOSR-828-65)
(AAR-8; AD-468765)

The problem of determining the transversal contour of a slender conical body of given length and base area so as to minimize the total drag (the sum of the pressure drag and the skin friction drag) in hypersonic flow is considered under the assumptions that the pressure distribution is Newtonian and the skin friction coefficient is constant. It is shown that, depending on the values of the length, base area, and skin friction coefficient, three kinds of solutions are possible: circular arcs, combinations of straight line segments tangent to a basic circle, and combinations of circular arcs and straight line segments tangent to the circular arcs. Similar results are proved to hold for a nonslender body. Author

N65-34528# Ling-Temco-Vought, Inc., Dallas, Tex. Vought Aeronautics Div.
ANALYSIS OF A FOLLOW-ON LOW SPEED WIND TUNNEL TEST OF A HIGH MASS RATE VECTORED PROPULSION FLOW MODEL
L. J. Mertaugh, Jr. and J. K. Davidson 31 Jul. 1965 109 p refs *Its* Rept.-2-53310/5R-2206
(Contract DA-31-124-ARO(D)-262)
(AROD-5260-4; AD-619578)

An analysis of data obtained from a second, low speed wind tunnel test of a semispan model of a VTOL aircraft is presented. The model features an integrated propulsion–lifting surface system as well as a horizontal tail located on an aft, wing tip extension. The propulsion system flow exhausts on the wing trailing edge flap and out of the lower surface of the wing. The exhaust flows can be independently vectored through 90 degrees. Force and moment data are presented with and without a simulated, stationary ground plane in place. Pressure data in the form of spanwise and chordwise pressure distributions are given for the wing and horizontal tail. Flow angularity measurements at the location of the horizontal tail are shown. The results of this analysis show that: (1) the maximum thrust removed lift coefficient for this wing is 2.7; (2) jet flap type pressure distributions are obtained on the wing; (3) there is no noticeable change in wing pressure distribution due to the presence of the horizontal tail; (4) there is a 7.7 percent reduction in static thrust due to the presence of the ground board; and (5) a significant variation in the flow field in the vicinity of the tail results from the different wing configurations. Author

N65-34538# Washington Univ., Seattle.
THE STUDY OF OPERATIONAL PROBLEMS AND TECHNIQUES IN WIND TUNNEL TESTING OF VTOL AND STOL VEHICLES Progress Report, 1 Oct. 1964–31 Mar. 1965
William N. Rae, Jr. [1965] 3 p
(Grant DA-ARO(D)-31-124-G481)
(PR-3; AD-619538)

Work continued in the development of an economical method of experimentally checking the effect of wind tunnel wall constraints on rotors, ducted fans, tilt props, and other methods of obtaining aircraft with V/STOL performance, by the use of inserts within a wind tunnel to simulate different size test sections. A hub hinge assembly was built for the four bladed rotor, and a series of tests were made using this rotor and inserts. Although preliminary data analyses indicate that the basic insert may be too short, and that the rotor with this disk loading is too large for the insert size at tip speed ratios below 0.10, modifications are being made for another test program. Test results were encouraging because some of the limits of the rotor size for a given disk loading tunnel cross section area and tunnel length were beginning to be defined. R.R.D.

N65-34552# Rice Univ., Houston, Tex.
THREE-DIMENSIONAL CONFIGURATIONS OF MINIMUM TOTAL DRAG IN NEWTONIAN FLOW
David G. Hull 1965 34 p refs
(Grant AF-AFOSR-828-65)
(AAR-5; AD-468762)

Variational problems associated with three-dimensional configurations (wings, bodies, and wing-body combinations) are considered, and the minimum drag problem is solved under the assumption that the base area and the wetted area are given while the length and the volume are free. Hypotheses used include: the configuration has two planes of symmetry, the angle of attack and the sideslip angle are zero, the pressure distribution is that pertaining to Newtonian flow, and the friction coefficient is constant. It is shown that the optimum configuration is governed by a first order, nonlinear, partial differential equation, and its general solution is presented in parametric form. The aerodynamic drag depends on the base area and the wetted area but is independent of the base shape. Therefore, the optimum configuration is not unique. As a particular case, homothetic configurations are considered, i.e., configurations whose transversal contours are geometrically similar to the contour of the base, and the associated optimum geometries are determined. R.N.A.

N65-34553# Rice Univ., Houston, Tex.
THREE-DIMENSIONAL HYPERSONIC SHAPES OF MINIMUM TOTAL DRAG
David G. Hull and Angelo Miele 1965 46 p refs
(Grant AF-AFOSR-828-65)
(AAR-6; AD-468763)

The necessary conditions to be satisfied by an extremal surface are discussed under the assumptions that the configuration has two planes of symmetry, the pressure distribution is Newtonian, and the skin friction coefficient is constant. For slender wings, the minimal problem is solved under various conditions imposed on the planform shape, the planform area, the distribution of thicknesses over the periphery of the planform, and the volume. For nonslender wings, fuselages, and wing-fuselage combinations whose lengths and volume are free, the minimal problem is solved for various conditions imposed on the base shape, the base area, and the wetted area. R.N.A.

N65-34651 Technische Hogeschool, Delft (Netherlands). Dept. of Aeronautical Engineering.
BOUNDARY-LAYER DISTURBANCE BY ISOLATED PROTUBERANCES OF VARIABLE HEIGHT ON A CYLINDER NOSE

E. Dobbinga *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 503–521 refs (See N65-34635 22-12)

The report describes measurements at low speeds of the transition of a boundary-layer in a favourable pressure-gradient, as affected by isolated protuberances. The roughness elements were installed on the cylindrical nose of a two-dimensional streamline body. The height of the protuberances could be varied continously and, by rotating the cylindrical nose, also the distance between the protuberance and the stagnation point could be changed. This preliminary report gives a general picture of the behavior of four types of roughness elements. The character of the disturbance changes markedly if the critical height of protuberances increases beyond a crucial value which is smaller than the boundary-layer thickness. The effect of protuberances appears in general to be very sensitive to the shape of the top. Author

N65-34652 National Physical Lab., Teddington (England). Aerodynamics Div.

SOME PROBLEMS OF FLOW LAMINARIZATION ON A SLENDER DELTA WING

N. Gregory and E. M. Love *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 523–566 refs (See N65-34635 22-12)

The problems are discussed in the light of an experimental investigation made in a low-speed wind tunnel on the effect of distributed suction on the state of the boundary layer on a slender delta wing of aspect ratio 1 with sharp leading edges. Laminar flow at high Reynolds numbers can be maintained on the upper surface with suction at negative angles of incidence where the flow is attached throughout, and at high positive angles of incidence in areas between the secondary attachment lines and some way outboard of them. Secondary separation is preceded by strong cross flow and insufficient suction was available either to eliminate separation or to avoid transition. At other incidences wedges of turbulence appear and ways of eliminating them need to be found. The phenomenon of transverse turbulent contamination associated with any excrescences near the apex and midspan remains a difficulty. Author

N65-34666 Royal Aircraft Establishment, Bedford (England).

TURBULENT BOUNDARY-LAYER STUDIES ON A WAISTED BODY OF REVOLUTION IN SUBSONIC AND SUPERSONIC FLOW

K. G. Winter, K. G. Smith, and J. C. Rotta (Aerodynamische Versuchsanstalt, Göttingen, West Germany) *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 933–961 refs (See N65-34653 22-12)

Experiments made on the body at Mach numbers between 0.6 and 2.8 at a length Reynolds number of 10^7 are compared with calculations, the basis of which is simultaneous integration along the body of the momentum and energy equations of the boundary-layer. The experimental measurements are the skin friction distribution along the body, obtained by the 'razor blade' technique, and boundary-layer surveys at six stations. The measurements support the general characteristics of the calculations except at the two highest Mach numbers (2.4 and 2.8). There is scope, however, for considerable further work to improve the understanding in detail. Author

N65-34667 National Physical Lab., Teddington (England). Aerodynamics Div.

VISCOUS INTERACTION EFFECTS IN LOW-DENSITY, SUPERSONIC STREAMS

E. W. E. Rogers and S. C. Metcalf *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 963–985 refs (See N65-34653 22-12)

The nature of viscous interaction in low-density, near-continuum flows is discussed and illustrated by means of experiments carried out in the NPL low-density tunnel. A distinction is drawn between leading-edge effects, associated with the rapidly-growing laminar boundary near the front of the body, and trailing-edge effects caused by the upstream penetration of the wake pressures and usually resulting in some modification to the boundary-layer profile. Because both viscous-interaction effects cause marked changes in the surface pressure-distribution (compared with inviscid or high-Reynolds-number flows) the body lift and drag may be very different from predictions which ignore these effects. Some discussion of the influence of low Reynolds number on lifting bodies is included in the text. Author

N65-34668 Polytechnic Inst. of Brooklyn, Farmingdale, N.Y. Dept. of Aerospace Engineering and Applied Mechanics.

VISCOUS-INVISCID INTERACTIONS ALONG A CORNER

Martin H. Bloom, Robert J. Cresci, and Stanley G. Rubin *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 987–1005 refs (See N65-34653 22-12)
(Contract AF 49(638)-1391)

A combined theoretical and experimental study of hypersonic flow along a corner is presented. The strong and weak interaction regimes are treated to determine the typical displacement induced effect on the inviscid flow. In this context the first order "inner" or boundary layer equations for the constant-density corner flow are discussed and similar solutions constructed for "outer" flows of the Falkner-Skan type. The nature of the cross-flows, and more specifically their effect on the boundary layer equations in the cross-plane, is described. Finally, pressure and heat transfer measurements for interaction parameters as high as 20 are reported. Author

N65-34669 Princeton Univ., N. J. Gas Dynamics Lab.

PRELIMINARY STUDIES OF THE FLOW AROUND TWO-DIMENSIONAL BODIES AT HIGH MACH NUMBERS AND LOW REYNOLDS NUMBERS

S. M. Bogdonoff and I. E. Vas *In* AGARD Recent Develop. In Boundary Layer Res., Pt. 2 May 1965 p 1007–1024 refs (See N65-34653 22-12)
(Contract AF 49(638)-1271)

A series of exploratory studies have been carried out to examine in detail the flow around bodies at high Mach numbers and low Reynolds numbers. The studies were primarily concentrated on the leading edge region where the shock wave and the viscuous region caused by the body itself interact. The detailed pressure distributions obtained over the body seemed to indicate significant deviations from the strong interaction theory, falling considerably below the theoretical results. Exploratory studies of the details of the flow field in this region indicate that a possible mechanism is the breakdown of the Rankine-Hugoniot shock wave in the region of interest. A new tool for study of this region indicates shock profiles which shows the changes in the structure of the phenomenon as one approaches the leading edge. Author

N65-34670 Naval Ordnance Lab., White Oak, Md.

LAMINAR AND TURBULENT BOUNDARY LAYERS ON SLIGHTLY-BLUNTED CONES AT HYPERSONIC SPEEDS

R. E. Wilson *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 1025–1048 refs (See N65-34653 22-12)

A momentum-integral method for calculating the boundary-layer growth on slightly-blunted cones has been given in a previous paper by the writer. The method, which applied to cones with fully laminar flow, is extended in the present paper to turbulent flow. In addition: transition data on cones at hypersonic speeds are examined to show the great effect of slight nose blunting on interpretation of the results, agreement between measured and calculated cone drag coefficients for fully laminar flow is demonstrated, and turbulent friction and boundary-layer thickness calculations are shown to agree with the limited amount of ballistic range data which are available. Author

N65-34689# Harry Diamond Labs., Washington, D. C.
SIMPLIFIED ANALOG SIMULATION OF FLUID CONTROL OF A ROCKET
J. V. Cuneo 1 Jun. 1965 16 p ref
(HDL-TM-65-27; AD-618196)

This report describes a simplified simulation of the control of a ballistic rocket in a horizontal plane. The purpose of the simulation was to investigate the effect of basic system parameters such as gain and limited corrective thrust on the reduction of dispersion caused by thrust malalignment. The parameters of the rocket model were of the early Little-john class, and the rocket was considered not to roll. The control system gain and corrective thrust parameters were based upon estimates of the performance of fluid control devices and methods. Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N65-33557 Wisconsin Univ., Madison.
NCAR AVIATION FACILITY
R. A. Ragotzkie *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 91–94 (See N65-33550 22-13)

An Aviation Facility was established to provide: (1) coordination within the scientific community of atmospheric research involving aircraft; (2) research and development of instrumentation, recording, and data reduction techniques required in the use of aircraft for research; (3) facilities, aircraft, and data reduction for atmospheric research by universities or other agencies; and (4) facilities, aircraft, and data reduction for NCAR atmospheric research projects. The Facility has been instrumented and is now operating a Beechcraft Queen Air 80 as a research aircraft. Additional aircraft will be obtained and a light weight airborne data recording system is under development. The Facility staff will operate the equipment and will also be available for consultation on aircraft matters to the scientific community in general. Author

N65-33642 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PARACHUTES FOR METEOROLOGICAL ROCKET APPLICATIONS
Harold N. Murrow *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 237–246 (See N65-3832 22-31)

Analaytical studies for comparison of various parachutes were made through application of the term W/C_DS, where W is the total weight of the descending system, C_D is the drag coefficient, and S is the area of material used in fabrication of the canopy. Determined were the basic altitude limitations, and the wind-following characteristics of parachutes and spheres at high altitudes. Experimenral studies of the deployment and subsequent flight characteristics of parachutes at high altitudes showed that silk parachutes experienced a great deal of violet breathing during the initial descent, and the installation of a torus near the skirt of the canopy as an inflation aid was recommended. G.G.

N65-33643 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
THE 8-FOOT PARACHUTE AS A WIND SENSOR
Marvin D. Kays *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 247–252 (See N65-33632 22-31)

An 8-foot parachute made of silk was successfully tested with the Judi and Loki rocket systems through ejection from the system at or near apogee. Full deployment occured almost immediately after expulsion. Fall rates between expulsion and deployment varied from 137 to 205 meters per second; the majority of the parachutes had fall rates of less than 15 meters per second below 90,000 feet. A 100 percent metalized parachute showed a fall rate of 158 meters per second at 200,000 feet as compared with 104 meters per second for a 50 percent metalized parachute. Radar reflectivity of the 50 percent metalized parachute was equal to that using the 100 percent metalized material. Wind sensitivity of the parachutes correlated well with 0.012 nylon chaff up to about 150,000 feet. Above this altitude, the chaff is more sensitive to shear forces. G.G.

N65-33690# Naval Air Test Center, Patuxent River, Md.
EVALUATION OF THE HYDRODYNAMIC CHARACTERISTICS OF THE JRF-5G HYDROFOIL SEAPLANE Final Report
Nicholas J. Vagianos and William B. Rhodes 21 Jul. 1965 54 p refs
(FT2121-35R-65; AD-468305)

Landing loads data obtained for the foil are presented as a function of landing sink speed. Sink rates up to 12 ft/sec were encountered without incident. The airplane was satisfactorily operated in waves up to 2 1/2 ft. Spray patterns during foil emergence and throughout the entire range of foilborne speeds are presented by photograph. The spray created at prehump speeds obscured forward vision and eroded the propeller tips. Take-off handling characteristics were unsatisfactory due to the extremely weak lateral control power and small amount of excess power available at hump speed. Foilborne handling qualities are: slightly negative static directional stability, difficulty in maintaining a selected roll attitude, and moderate control power about all three axes. The upper hydrodynamic stability limit for the system is characterized by heaving and/or bouncing. Author

N65-33698# Bell Aerosystems Co., Buffalo, N. Y.
X-22A TRI-SERVICE V/STOL AIRCRAFT Monthly Progress Report No. 28, Mar. 1965
15 Apr. 1965 29 p
(Contract NOw-63-0118-ci)
(BAC-2127-933028; AD-465214)

Achievements in the areas of design, models, test stands, and manufacturing are reported for the X-22A tri-service V/STOL aircraft. Flight technology, vehicle structure, systems support, and systems analysis and simulation are discussed. The wind tunnel test program, propulsion system test stand, and flight control are also considered. C.T.C.

N65-33765# Aviation Safety Engineering and Research, Phoenix, Ariz.

CARGO RESTRAINT CONCEPTS FOR CRASH RESISTANCE

James P. Avery Ft. Eustis, Va., Army Aviation Materiel Labs., Jun. 1965 60 p refs

(Contract DA-44-177-AMC-116(T))

(AvSER-64-13; USAAML-TR-65-30; AD-618493)

This report covers an investigation of three cargo restraint concepts: (1) an extensible-net-type restraint (such as a nylon net) secured directly to the airframe, (2) the same extensible net attached to load limiters (attenuators), and (3) an inextensible-net-type restraint (such as a steel net) attached to load limiters. Each concept was invesigated analytically using computer simulation to determine the dynamic performance of the system under the action of crash acceleration pulses. Drop tests were also conducted to verify analyses. General comparisons were made to obtain the advantages and shortcomings of each restraint concept as well as the influence of controllable parameters. A substudy of the nature of the probable crash induced acceleration pulse was also undertaken. This led to a proposed standard pulse for cargo restraint design purposes. Author

N65-33796# Ling-Temco-Vought, Inc., Dallas, Tex. LTV Vought Aeronautics Div.

XC-142A VTOL TRANSPORT PROGRAM Monthly Progress Report, Dec. 1964

W. J. Hesse [1964] 29 p

(Contract AF 33(657)-7868)

(MPR-36; AD-463107)

A significant milestone in the XC-142A program was accomplished during the month when the first hover flight was achieved on 29 December, three months after first flight with very satisfactory results. The flight, made on the number 2 aircraft, included hovering at five feet, heading changes of 45° right and left, translations forward and back and left and right at distances up to ten feet. An additional significant event occurred when the number 3 aircraft made its initial flight on 11 December. Thirteen flights have been achieved on the number 2 aircraft for a total cumulative flight time of 11 hours and 53 minutes and five flights have been accomplished on the number 3 aircraft for a total cumulative flight time of 4 hours and 29 minutes. Author

N65-33967*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ANALYTICAL INVESTIGATION OF A HELICOPTER ROTOR DRIVEN AND CONTROLLED BY A JET FLAP

William T. Evans and John L. Mc Cloud III Washington, NASA, Sep. 1965 49 p refs

(NASA-TN-D-3028) CFSTI: HC $2.00/MF $0.50 CSCL 01C

Results of a theoretical study of the characteristics of a particular jet-flat rotor are presented and analyzed. The study made extensive use of high-speed digital computations. It was found that the momentum and power coefficients varied significantly with shaft angle for many flight conditions. This finding is rationalized, and its significance explored. It was also found that higher harmonic control of the flap reduced higher harmonics of blade flapping, thrust, and torque. The study indicated that higher speeds can be attained in pure helicopter flight than with any conventional rotor. It further indicated that the maximum attainable speed in such flight is likely to be higher if theoretical supercirculatory thrust recovery on the blade is *not* realized in practice. Author

N65-34253# Advisory Group for Aeronautical Research and Development, Paris (France).

ACTUAL STATE OF STUDIES ON THE V/STOL IN FRANCE [ETAT ACTUEL DES ETUDES SUR LE V/STOL EN FRANCE]

G. Leblanc and G. Klopfstein Oct. 1964 8 p In FRENCH; ENGLISH summary

(AGARD-487) CFSTI: HC $1.00/MF $0.50

The main studies in France concern a vertical take-off interception aircraft, Mirage III V, and a short take-off transport plane, the Bréguet 941. After giving a reminder of the main characteristics of both these families of aircraft, the authors provide a few results of trials in flight, particularly flight qualities. The emphasis bears on the possible use of delta effect increase, caused by the jet induced lift loss on Mirage III V and, in the case of Bréguet 941, by the flexibility of holding of the glide path through the use of the flaps. Author

N65-34272# Ling-Temco-Vought, Inc., Dallas, Tex. LTV Vought Aeronautics Div.

VTOL TRANSPORT PROGRAM Monthly Progress Report No. 32, Volume 32 for Aug. 1964

L. C. Josephs [1964] 34 p

(Contract AF 33(657)-7868)

(XC-142A; AD-464587)

Progress of the XC-142A VTOL transport program is reported. Initial taxi tests up to 60 knots on the #2 aircraft were conducted and planned effort on the flight control simulator was completed. The static test wing failed while undergoing a 3.8 G gust condition test as the result of instability in the wing main splice area at 110 percent of limit load. Required rework and possible restrictions on the early phase of the flight test program are under evaluation. A formal flight safety inspection was conducted on the #2 aircraft. G.A.L.

N65-34283# Bell Helicopter Co., Fort Worth, Tex.

MANEUVERABILITY DATA FROM AN ARMY HELICOPTER FLYING A SIMULATED ARMAMENT MISSION

Frank B. Burpo Apr. 1965 44 p refs Prepared in Cooperation with the Army

(Rept.-831-099-003; AD-464836)

Data are presented from a flight test program conducted using an Army helicopter flying a simulated armament mission and maneuvers in the nap-of-the-earth environment. A UH-1B helicopter was flown by U.S. Army pilots through maneuvers suggested by Army personnel at Ft. Rucker, Alabama. Flight test data were recorded at Ft. Rucker and at Ft. Benning, Georgia in March, 1964. Maximum and minimum values are presented for main motor rpm, airspeed, controls positions, accelerations at the c.g., rates about three axes, and pitch and roll attitude encountered for various segments of the flight profile. The instrumentation and the flight tests are discussed and pilot comments are included. The maximum g's recorded are surprisingly low; however, the ship was flow through typical maneuvers, not structural. Pilot comments indicated that the instruments of primary concern were the main rotor tachometer and exhaust gas temperature indicator. Author

N65-34437*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

FLIGHT PRESSURE DISTRIBUTIONS ON THE VERTICAL STABILIZERS AND SPEED BRAKES OF THE X-15 AIRPLANE AT MACH NUMBERS FROM 1 TO 6

Jon S. Pyle Washington, NASA, Oct. 1965 56 p refs
(NASA-TN-D-3048) CFSTI: HC $3.00/MF $0.50 CSCL 01C

Flight pressure distributions are presented for the upper and lower vertical stabilizers of the X-15 airplane with the speed brakes deflected up to 35° at Mach numbers from 1 to 6 and angles of attack from 0° to 15°. Wind-tunnel results agreed well with the flight data. Linear theories provided fair agreement with the flight data when the speed brakes were retracted. The surface loads on the upper rudder were greatly reduced at the higher angles of attack at supersonic Mach numbers. The speed-brake normal-force and hinge-moment coefficients decreased with increasing Mach number on the upper speed brake. Speed-brake drag, measured from surface pressures in flight, compared favorably with measurements obtained from accelerometers, wind-tunnel force-balance data, and semi-empirical estimates. Author

N65-34439# Advisory Group for Aeronautical Research and Development, Paris (France).

APPROACH AND LANDING PROBLEMS IN JET VTOL AIRCRAFT

F. P. Youens Oct. 1964 37 p Presented at the AGARD Flight Mech. Panel, All Weather Operation Meeting, Munich, 12–13 Oct. 1964
(AGARD-489) CFSTI: HC $2.00/MF $0.50

The paper discusses the general problem of approach and landing for jet lift VTOL aircraft with emphasis on the tactical aircraft operating from a dispersed base. The influence of operational environment and the general characteristics of this type of aircraft on the approach technique is considered along with a more detailed survey of the transition phase including cross-wind transition limits and control techniques. Against this general background the pilot's problem and the function of various instrument and control aids are considered. Author

N65-34533# Walker (Norman K.) Associates, Inc., Bethesda, Md.

ROLL STABILITY OF GROUND EFFECT MACHINES—THICK ANNULAR JET AND PLENUM TYPES Final Report, May–Sep. 1963

Norman K. Walker, David A. Shaffer, Alastair Anthony, and Richard Brooks Ft. Eustis, Va., Army Transportation and Res. Command, Jun. 1965 66 p refs
(Contract DA-44-177-AMC-19(T))
(USAAML-TR-65-27; AD-617129)

An electrically powered model Ground Effect Machine, first arranged with a thick annular jet and second as a simple plenum chamber, was used in an investigation of the roll stability in hovering flight. The height, lift, and power relationship was determined and the restoring moment and side force due to inclination to the ground were measured. The dynamic stability was observed with the machine supported on pivots which were free to move sideways. These were first located close to the base of the model and then at intermediate and high positions above the base. Low and high positions of the model center of gravity were available. Finally, the model was flown without any constraints, in both versions and at both CG heights and at an extra high CG position with overload ballast. Author

N65-34543# Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex. Environmental Sciences Directorate.

INVESTIGATION OF THE EFFECT OF LAPSE RATE ON BALLOON ASCENT RATE Final Report

Ralph D. Reynolds May 1964 15 p refs
(ERDA-140; AD-600433)

The relationship between temperature lapse rate and balloon ascent rate has been investigated for large (2000 pound gross load) polyethylene "skyhook" balloons and the relatively small neoprene rawinsonde balloon. In general, the results indicate that the lapse rate is a minor factor in determining balloon ascent rate and should be considered only after other pertinent factors are better understood. Author

N65-34707# Bolt, Beranek, and Newman, Inc., Los Angeles, Calif.

ANALYSIS OF COMMUNITY AND AIRPORT RELATIONSHIPS/NOISE ABATEMENT. VOLUME I: AN APPROACH TO ANALYSIS OF AIRCRAFT NOISE PROBLEMS USING COMPUTER-AIDED TECHNIQUES Technical Report, May 1963–Apr. 1964

Welden E. Clark Dec. 1964 68 p refs
(Contract FA-WA-4409)
(BBN-1093; SRDS-RD-64-148; I; AD-618190) CSCL 01B

Engineering and research activities directed towards determining the technical basis and procedures for assessing and predicting community response to noise are investigated. Volume I summarizes the development of a computer-aided approach to the analysis of aircraft noise as it affects communities near airports. Volume II describes in detail two simplified procedures for analyzing aircraft noise in the vicinity of airports to determine: (a) whether or not aircraft noise will interfere with work activities or land use; and (b) what building arrangements and construction features should be incorporated in building design so that aircraft noise will not interfere with activities inside the building. Volume III of the report discusses legal aspects helpful in understanding some of the actions taken by individuals or by groups in a community responding to aircraft noise. Author

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N65-33707*# Stanford Univ., Calif.

THE NONEXISTENCE OF DC STATES IN LOW PRESSURE THERMIONIC CONVERTERS

Peter Burger [1964] 8 p refs
(Grant NsG-299-63)
(NASA-CR-56756) CFSTI: HC $1.00/MF $0.50 CSCL 10A

A computer program was developed to simulate the large signal time-dependent behavior of low pressure thermionic converters. The thermionic emitters of the model were simulated by giving the charged electron and ion sheets injected into the space of the converter random velocities distributed by the half-Maxwellian distribution law; the procedure is similar to the Monte Carlo method. Analyses of possible dc states

of such a system are discussed, and the findings considered in the computer calculations. Results showed that the low pressure thermionic converter does not have a dc state for large electron currents through the diode, and that the current through the diode has large amplitude fluctuations. M.G.J.

N65-33758# Cubic Corp., San Diego, Calif.
FEASIBILTY STUDY FOR A VEHICLE ATTITUDE DETERMINING SYSTEM. VOLUME II: DETAILED ANALYSES OF ANTENNAS, PROPAGATION, POLARIZATION, AND PERFORMANCE Final Report
Griffiss AFB, N. Y., RADC, Nov. 1964 294 p refs
(Contract AF 30(602)-3135)
(RADC-TDR-64-318, Vol. II; AD-609751)

Detailed analyses of antennas, propagation, polarization, and performance are given in a feasibility study for a vehicle attitude determining system. Constraints placed on the proposed attitude measurement systems are considered in the antenna analysis. An interferometer, a system for measuring the polarization of the signal received at the ground, and a system to determine the orientation of the vehicle are discussed. Effects of the atmosphere on the propagation of microwave signals are given and include derivations and computations of their magnitudes. The polarization of electromagnetic waves is analyzed, and a typical polarimeter is examined. Polarization measurement errors in ground station antenna systems, and polarization orientation errors in vehicle antennas are also analyzed. Mathematical solutions and error analyses are given for the various attitude determining systems. A brief analysis is included for the multipath error and inverted conical scan antenna pattern. C.T.C.

N65-33790# Royal Aircraft Establishment, Farnborough (England).
THE DESIGN OF A HIGH EFFICIENCY LOW POWER VOLTAGE REGULATOR FOR SATELLITES
P. J. Keyte Mar. 1965 58 p refs
(RAE-TM-SPACE-57; AD-465342)

This Technical Memorandum describes a low power switch type regulator which delivers 10 volts from a supply varying between 12 and 16 volts. It uses only four transistors and has an efficiency of 92.5% when delivering 2 to 6 watts at 10 volts from a 12 volt supply. For supply variations from 12 to 16 volts and load variations from open circuit to 6 watts, the overall load and line regulation at constant temperature is 0.1%. With a temperature variation of −20° C to 60° C the regulation is 1%. Design data is given which is applicable to most switch type regulators. The weight of the complete unit is approximately 0.23 Kgm contained in a volume of 170 cc. Author

N65-33825*# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
IMPROVED MAGNETIC COMPONENTS FOR STATIC INVERTERS AND CONVERTERS Seventh Quarterly Report, Dec. 29, 1964–Mar. 30, 1965
R. E. Mc Vay et al [1965] 39 p refs
(Contract NAS3-2792)
(NASA-CR-54645; WAED-65.44E) CFSTI: HC $2.00/MF $0.50 CSCL 10A

Sine current screening CCFR and sine flux screening core loss tests were made on part of the test program materials. Square wave CCFR tests at 400, 800, 1600, and 3200 cps were made on part of the test materials. Results are tabulated. A description of the annealing treatments for the materials, the equipment check out problems, the program drawings and the toroidal core description are given. A proposed change in shock testing is discussed. The noise testing facilities are discussed. Author

N65-33829*# General Electric Co., Pleasanton, Calif. Special Purpose Nuclear Systems Operations.
RESEARCH PROGRAM FOR THE LONG TERM TESTING OF CYLINDRICAL DIODES AND THE IRRADIATION OF FUEL AND INSULATOR Sixth Quarterly Summary Report, Sep. 18–Dec. 17, 1964
17 Dec. 1964 84 p refs
(Contract NAS3-2544)
(NASA-CR-54384; GEST-2045) CFSTI: HC $3.00/MF $0.75 CSCL 10A

Thermionic converter 301 was disassembled and inspected to determine failure. Since there was no evidence of a cesium leak into the bombardment chamber, the converter was reassembled using a new bombardment gun assembly. Out-of-pile testing was resumed with definite proof of a cesium leak. Out-of-pile converters 311 and 312 were operated for 4480 and 3858 hours and are continuing. Converter 313 processing was completed and it was placed on life test. The thermal and stress analysis of a 3-cell segment of a thermionic fuel element was completed and a thermal cycling test initiated. Additional effort was placed on the design of the W–25Re clad fueled UO_2 electrically heated converter. In the thermal and irradiation testing of fuel/clad emitters, all materials necessary for the compatibility tests were received. W–25Re capsules containing UO_2 were prepared and installed in the cesium retorts, and some furnace tests begun. The vertical adjustable facility tube was tested out-of-pile and found satisfactory for reactor use. The alumina radiation capsule continued its irradiation in PBR through cycle 29 and reached an approximate dose of 1.6×10^{20} nvt of neutrons with energy greater than 1 MeV. R.N.A.

N65-33870*# Yardney Electric Corp., New York.
RESEARCH AND DEVELOPMENT OF THE SILVER OXIDE-CADMIUM ELECTROCHEMICAL SYSTEM Second Quarterly Progress Report, 10 Feb.–9 May 1965
Allen Charkey [1965] 47 p *lts* Rept. No. 544-65
(Contract NAS5-9106)
(NASA-CR-64994) CFSTI: HC $2.00/MF $0.50 CSCL 10C

Electrode reactions in a sealed silver oxide-cadmium cell were investigated and methods for improving performance characteristics and reliability of the cell system were studied for spacecraft application. Only minor performance variations are found when the cells are charged and discharged at temperatures between 10° and 40° C; but a voltage dip is exhibited by the cathode when cells are charged at room temperature and discharged at −10° C. No dip occurs when discharge is preceded by a charge below 5° C. Two sealed cells perform somewhat better than two cells used as controls; and dissection of a sealed cell after deep cycling indicates it retained more of its original capacity than did the standard positive and negative plates used as controls. Cells with impregnated cadmium electrodes in a porous silver matrix completed 380 deep cycles before shorting. Cycle data from cells fabricated with high surface area CdO show about 12–15% better capacity than control cells after 250 cycles; and cadmium electrodes doped with Fe_2O_3 exhibit about 10% better material utilization at −10° C than untreated electrodes. M.W.R.

N65-33877*# General Electric Co., Philadelphia, Pa. Spacecraft Dept.
SOLAR THERMIONIC FLIGHT EXPERIMENT STUDY. VOLUME 1: STUDY SUMMARY Final Report, Jul. 1964–Apr. 1965

1 May 1965 69 p Prepared for JPL *Its* Doc. No. 655D4286
(Contracts NAS7-100; JPL-950852)
(NASA-CR-64889) CFSTI: HC $3.00/MF $0.75 CSCL 10A

This report covers a study program to establish the governing parameters for an experimental flight test of a solar thermionic electrical power system. Three different missions are suggested for the flight experiment. Selection of the orbit, launch vehicle, appropriate secondary experiments and thermionic system size is made for each mission. Conceptual spacecraft designs are included for each of the suggested missions. Conceptual designs are developed for the primary and secondary experiments, and the major spacecraft subsystems. Drawings are presented for the resulting spacecraft configurations. The results of the study indicate that a successful thermionic flight experiment is within the present component state-of-the-art. In addition the study results show that a sum pointing spacecraft of the type required for conducting a solar thermionic flight experiment offers an attractive space platform from which many valuable scientific and engineering experiments could be performed. Author

N65-33900# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
NEW TRENDS IN NONFLOATED PRECISION GYROSCOPES
Paul H. Savet (Am. Bosch-Arma Corp.) Oct. 1964 31 p refs
(RM-247J)

Among the recently developed, high precision, non-floated two degree of freedom gyroscopes, two newcomers are considered. They are the Free Gimbal gyro and the Vibra Beam gyro. The first of these is closely related to the Dynamically Tuned Free Rotor Gyro devloped by Arma, except that the rotor has been removed and the inertial element reduced to the elastically mounted gimbal ring. The second gyro is also closely related to the Arma development mentioned, but in this design the gimbal ring has been removed and the rotor is suspended by a set of elastic beams upon the drive or input shaft. In both of these new approaches a perfect elastic decoupling from the input shaft has been achieved. An analysis of these phenomena is offered and their application to this new gyro technology is critically reviewed. Author

N65-33961*# National Aeronautics and Space Administration, Washington, D. C.
ADDITIONAL ENERGY LOSSES IN COOLED GAS-TURBINE POWERPLANTS AND THEIR INFLUENCE ON SPECIFIC CYCLE PARAMETERS [DOPOLNITEL'NYYE POTERI ENERGII V OKHLAZHDAYEMYKH GTU I IKH VLIYANIYE NA UDEL'NYYE PARAMETRY TSIKLA]
V. I. Lokay and R. G. Khayrullin Sep. 1965 11 p refs Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekh. (Kazan), v. 8, no. 2, 1965 p 152–158
(NASA-TT-F-9570) CFSTI: HC $1.00/MF $0.50 CSCL 10A

Discussion of the additional energy losses that take place in a gas turbine with air- or liquid-cooled vanes, as compared to the uncooled version of the turbine. Three types of principal losses are examined: (1) additional hydraulic losses caused by both the inferior geometry of the working section and the structural changes in the cooled boundary layer on the rotor vanes, which, it is shown, for an appropriate geometry of the cooled vanes need not exceed 1.5 to 2 percent; (2) additional thermodynamic losses arising from heat release by the gas when expanding in the working section, which, in the case of air-cooling, are shown to be small but, in the case of multistage high-temperature turbines employing liquid cooling, will exceed the combined other losses; (3) additional energy losses associated with the supply of the cooling medium to the vanes. The effect of the individual type of losses on the cycle parameters is examined. Author

N65-34010*# Atomics International, Canoga Park, Calif.
RADIATION EFFECTS ON SILVER AND ZINC BATTERY ELECTRODES, I Interim Report, Apr.–Jul. 1965
G. R. Argue, H. L. Recht, and W. A. Mc Collum 16 Aug. 1965 23 p ref Prepared for JPL
(Contracts NAS7-100; JPL-951109)
(NASA-CR-64970; AI-65-158) CFSTI: HC $1.00/MF $0.50 CSCL 10A

Studies are underway to determine the level at which radiation damage would start in an Ag–Zn system. Cadmium electrodes were substituted for zinc as excessive growth of dendrites occurred during initial capacity measurement cycles. Material lost from the silver electrode was observed on the bottom of the cell after every irradiation. One silver electrode with a capacity of 0.8A-h lost 54 mg of material after a gamma dosage of 1.1×10^8 rads (H_2O); an identical unirradiated electrode at the same temperature (45° C) and cycling conditions lost only 4.1 mg of material. Small gamma radiation dosages proved sufficient to initiate precipitation of silver metal from the solution containing a charged silver electrode; the effect was observed after a 5-min irradiation [10^5 rads (H_2O)]. The precipitated silver metal appeared to be the product of radiation-induced reduction of silver oxides in solution. M.G.J.

N65-34044# Martin Co., Baltimore, Md. Nuclear Div.
THE PERFORMANCE OF RUTHENIUM AS AN ELECTRODE IN A THERMIONIC CONVERTER
A. J. Kennedy and D. S. Trimmer [1965] 9 p refs
(Contract Nonr-3639(00))
(AD-965704)

Ruthenium, a material having relatively low adsorption cross section in both thermal and epithermal regions of the neutron spectra, was investigated as an emitter and as a collector in a thermionic converter. Both hot pressed and plasma sprayed ruthenium emitters behave like high vacuum work function materials, i.e., display high output current density at a relatively low cesium pressures. Significant differences are noted, however, in the performance of the two ruthenium emitters prepared by the different processes. The performance is compared to that of iridium and rhenium, the ruthenium showing generally a higher output power density, particularly at moderate (10 to 30 mil) values of interelectrode gap. A plasma sprayed ruthenium collector assumes its optimum at a temperature approximately 100° K lower than that for a molybdenum collector, the value of collector work function at optimum being the same, within the limits of experimental uncertainty, for the two materials. Author

N65-34047# Frankford Arsenal, Philadelphia, Pa. Research and Development Directorate.
PROPELLANT ACTUATED DEVICES Quarterly Progress Report, Jan.–Mar. 1965
[1965] 108 p refs
(PAD-98-1; AD-464582)

Development programs relating to propellant actuated devices (PAD) were conducted. The work covered includes the design of specific devices, such as thrusters, catapults, and initiators; investigations of related subjects, such as propellants and structural materials; and feasibility studies, aimed at improving the performance of propellant actuated devices and extending their application. W.M.R.

N65-34048# Republic Aviation Corp., Farmingdale, N. Y.
INVESTIGATION OF PULSATING FLOW HYDRAULIC CONCEPTS Third Quarterly Progress Report, 1 Nov. 1964–1 Feb. 1965
15 Feb. 1965 35 p
(Contract AF 33(615)-1582)
(RAC-1932-3; AD-463705)

During the period, detail design of the alternator valve was completed. The piston-type transformers, fluid volume control unit, and rectifier valve were fabricated and subjected to individual component tests. Assembly of the rig for system operational investigation was started. An additional system comparative analysis was made to determine whether operation at higher pressures would result in a weight saving over the system previously analyzed and reported. Author

N65-34103# Giannini Controls Corp., Malvern, Pa. Astromechanics Research Div.
RESEARCH STUDIES IN PROPORTIONAL FLUID STATE CONTROL COMPONENTS (PART 2)
H. A. Curtiss, D. J. Liquornik, and S. K. Ho Mar. 1965 69 p refs
(Contract DA-36-034-ORD-3722(RD))
(ARD-TR-013-02; AD-618103)

Results of experimental research performed on the Double Leg Elbow Amplifier (DLEA) are presented. The DLEA with a straight active leg, was operated in a closed configuration. Tests were conducted with hot gas as a working medium, and two amplifiers were coupled and tested as a two stage amplifier. The DLEA was optimized for power gain. In addition, analytical techniques were expanded to include the effect of the splitter on the DLEA performance. It was concluded that the optimized Double Leg Elbow Amplifier would be excellent in control applications demanding high mass flow gains and high power gains especially when used to control gasses at extremely high temperatures. Author

N65-34160# Naval Ordnance Lab., Corona, Calif.
CHEMOELECTRIC ENERGY CONVERSION FOR NONAQUEOUS RESERVE BATTERIES Quarterly Report, Apr.–Jun. 1965
R. E. Panzer et al 15 Jul. 1965 20 p refs
(NAVWEPS-8821; AD-619655)

Experimental investigations of reference electrodes for use in pressurized liquid ammonia electrochemical systems are reported, various types of electrodes based on metallic lead and lead compounds are compared. Also, tests on thin cells in which conventional electrolytes have been eliminated indicate the feasibility of using such cells for hardware applications. In addition, experiments with the electrolyte solution-activation method are discussed. J.M.D.

N65-34166# Magna Corp., Anaheim, Calif.
BIOCHEMICAL FUEL CELLS Final Report, 1 Jul. 1962–31 Mar. 1965
Jon M. Brake [1965] 190 p refs
(Contract DA-36-039-SC-90866)
(STL-4399-6001-RU-000; AD-619665)

A summary of the first years of an investigation into biochemical fuel cells is presented. The systems investigated included the hydrogen producers *Clostridium butyricum* and *Escherichia coli;* the ammonia producers *Bacillus pasteurii*, urease and L-amino acid oxidase; and the formic acid producers *Aeromonas formicans* and *Escherichia coli*. The effects of temperature, pH, ionic strength and substrate on the rate of production of these fuels are reported. Electrochemical studies of the fuels were made under conditions compatible with their production. Formic acid proved to be the best choice. Current densities up to about 40 mA/cm^2 were obtained with this fuel. Formic acid was produced in practical quantities from sugar, coconut juice, fruit juices and extracts of yams. A biochemical battery operating on coconut juice was used to operate a transistor radio intermittently over 45 days for a total of 50 hours. The coulombic efficiency of the cell approached 100% of the formic acid produced. Author

N65-34228*# General Electric Co., Gainesville, Fla. Battery Business Section.
DEVELOPMENT OF A NICKEL CADMIUM STORAGE CELL IMMUNE TO DAMAGE FROM OVERDISCHARGE AND OVERCHARGE
A. J. Catotti and M. D. Read 21 Jun. 1965 68 p
(Contract NAS5-3707)
(NASA-CR-62019) CFSTI: HC $3.00/MF $0.75 CSCL 10A

The development of nickel–cadmium cells which are immune to damage from overcharge and overdischarge is given. This was accomplished by the selection of suitable gas electrodes so that the onset of overcharge can be detected, and the cell cannot be damaged by repeated overdischarges. All technical and experimental aspects of the development are given. Tabulated data includes polarization of oxygen electrodes at various pressures and current densities, hydrogen polarization, results of overdischarge cycle, formation and acceptance tests, and overcharge tests at various temperatures. C.T.C.

N65-34230*# Livingston Electronic Corp., Montgomeryville, Pa.
DEVELOPMENT OF HIGH ENERGY DENSITY PRIMARY BATTERIES 200 WATT HOURS PER POUND TOTAL BATTERY WEIGHT MINIMUM Third Quarterly Report, 10 Dec. 1964–0 Mar. 1965
Sandors G. Abens [1965] 68 p ref
(Contract NAS3-6004)
(NASA-CR-54659) CFSTI: HC $3.00/MF $0.50 CSCL 10A

Electrolyte and electrode studies for the development high energy lithium-anode primary cells were conducted. The stability of lithium in the lower esters with and without $LiClO_4$ solute was determined. Methyl formate was less reactive than ethyl formate, but produced 117 psig of pressure. The specific conductance of various organic electrolyte solutions was not strongly affected by atmospheres of NH_3, SO_2, or CO_2. Powdered lithium metal was an effective water removing agent for organic solvents. In experimental CuF_2Li cells, 79 percent cathode efficiency was recorded in methyl formate-$LiClO_4$ at 1 mA/cm^2, and 50-70 percent in propylene carbonate-$LiClO_4$ electrolyte at 0.5 mA/cm^2. Author

N65-34270# Westinghouse Electric Corp., Elmira, N. Y. Electronic Tube Div.
APPLICATION OF LIGHT AND IMAGE INTENSIFICATION Monthly Technical Engineering Report, Feb. 1–28, 1965
Z. Szepesi, ed. 17 Mar. 1965 18 p
(Contract N61339-1440)
(MTER-20; AD-462978)

Opto-electronic characteristics of sandwich CdSe PC cells, made from sublimed powder, were measured and evaluated regarding the dependence on the processing parameters. More sintering tests are being made at higher temperatures. The

effect of gold electrodes on sintered CdSe sandwich cells has been studied at different baking temperatures and it was found that above 350° C (and 1/2 hour baking) an appreciable dark current increase is caused by the gold. Indium sulfide powder was purified and cadmium-indium sulfide powder was prepared. A radiation heated evaporator unit was fabricated. Sintered CdSe and EL film compatibility tests were made. Author

N65-34284# Bermite Powder Co., Saugus, Calif.
PERCUSSION PRIMER SYSTEMS Semiannual Progress Report No. 2
S. S. Rovner 9 Mar. 1965 42 p
(Contract NOw-64-0357-c)
(BPC-465; AD-464842)

The objective of this program is to obviate the electromagnetic radiation (EMR) hazards inherent in electrically-initiated explosive trains. The M42 percussion primer was utilized for study, testing, and analyses to obtain basic data for the design and development of hydraulic-mechanically operated percussion-primer systems. Test apparatus was developed to conduct firings of these percussion primers, and for testing a fixture having a 90° elbow between the primer and booster and the igniter. Two prototypes of BPC hydraulic-mechanically operated percussion-primer systems were completed and assembled. Both these units have already been successfully test fired and proved the complete feasibility of the systems. One unit was shipped to BuWeps; the other will be tested with a live JATO motor for a BuWeps representative before being shipped. This research program has been extended to include the design and development of a new ignition system that is hydraulically actuated and mechanically operated. Comparative data have been obtained from tests between igniters fired with 35019K initiators and that of a hydraulic-mechanically operated firing apparatus. Author

N65-34427*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THERMAL CYCLING AND HEAT DAMAGE TESTS OF THIN-FILM CADMIUM SULFIDE SOLAR CELLS
John G. Ewashinka and George K. Stephenson, Jr. Washington, NASA, Oct. 1965 ref
(NASA-TN-D-3038) CFSTI: HC $1.00/MF $0.50 CSCL 10A

Heat damage and thermal cycling tests were performed on thin film cadmium sulfide solar cells to determine the suitability of these cells for operation in a space environment. The temperature range was 80° to 200° C for heat damage studies and −90° to 62° C for thermal cycling tests. Test durations for heat damage and thermal cycling studies were 586 hours and 1600 cycles, respectively. Mechanical and physical weaknesses in the cell design were uncovered during heat damage tests. These weaknesses, which consisted of faulty cell contacts and delamination of plastic encapsulant, were overcome by soldering the contacts to the cell structure and by using a high temperature encapsulant. Degradation of cell output at elevated temperatures was evident at 200° C for the heat damage tests; the cell output, however, stabilized after the temperature was reduced below 200° C, which indicated that no damage to the cell junction had occurred. Thermal cycling tests revealed several cell problem areas, which included loss of cell contact between gold grid and silver collecting straps, failure of cell encapsulant, and short circuiting of the cell caused by the type of grid used. These problems were solved by the use of a high-temperature encapsulant. Author

N65-34561# Melpar, Inc., Falls Church, Va.
BIOCHEMICAL FUEL CELL Quarterly Progress Report, 1 Jan.–31 Mar. 1965
Gordon C. Blanchard and Charles R. Goucher [1965] 55 p refs
(Contract DA-36-039-SC-90878)
(Rept.-11; AD-619779)

The studies carried out have been more successful in showing the feasibility of using microorganisms for power production than any other study previously reported. It was demonstrated that the coupling of the 10-liter microbial hydrogen generator to a hydrogen–oxygen fuel cell produced one watt of power continuously for a period of 8 hours. No lag period was observed and hydrogen production continued for 8 hours without adjusting pH or substrate concentrations in the fermenter; adjustment of these factors would have resulted in more hydrogen, and thus, more power. Several natural products were evaluated as substrates for hydrogen generation by *Clostridium welchii*. The vegetables, fruits, and grains tested included banana, cucumber, squash, grape, peach, orange, artichoke, rice, avocado, sweet potato, pineapple, apple, bean, and plum. The natural products are listed in the order of their importance as substrates for hydrogen. The large hydrogen output from cucumber, which has the lowest carbohydrate content of any of the natural products tested, indicates that other compounds in natural products may be more important sources of hydrogen than carbohydrates. Author

N65-34618* Republic Aviation Corp., Farmingdale, N. Y.
OPTIMUM SOLAR CELL SHIELDING FOR THE ADVANCED ORBITING SOLAR OBSERVATORY
Howard Weiner *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 377–395 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Protection of solar experiments against extraneous radiation is considered for the Advanced Orbiting Solar Observatory. The sources of unwanted radiation are particles in the trapped radiation belts and solar flare protons over the polar caps. Prevention of solar cell degradation by cover-glass shielding on the paddles is found to involve excessive weight penalty; instead, it is recommended that the number of solar cells be increased to allow for a certain amount of degradation. J.M.D.

N65-34675# Joint Publications Research Service, Washington, D. C.
SELECTION OF BUS REACTOR FOR REGULATION OF GENERATOR VOLTAGE
N. V. Gorin 21 Sep. 1965 6 p Transl. into ENGLISH from Elektricheskiye Stantsii (Moscow), no. 8, Aug. 1965 p 51–53 (JPRS-32084; TT-65-32577) CFSTI: $1.00

Advisability of using a bus reactor in the main distributing unit of industrial thermoelectric powerplants is discussed. Rated currents of the bus reactor are calculated. Bus reactors are considered necessary only if one or two counterpressure turbine generators or turbines with capacitors are installed in the thermoelectric powerplant. Omission of the bus reactor simplifies the construction of the main distributing unit and increases the reliability of the power supply. J.M.D.

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; protective clothing and equipment; physiological and psychological factors. For related information see also: 05 Biotechnology.

N65-33589 Michigan Univ., Ann Arbor.
POTENTIAL APPLICATIONS OF REMOTE SENSING TO ECOLOGICAL RESEARCH
Charles F. Cooper *In its* Proc. of the 3d Symp. on Remote Sensing of Environment, Feb. 1965 p 601–606 refs (See N65-33550 22-13)

Field investigations of the behavior of natural plant communities require knowledge of physical and biological characteristics integrated over areas of a few square feet to several square miles. Important properties potentially measurable by remote sensing techniques, singly or in combination, include leaf area, volume, weight, and chlorophyll content of vegetation; heat budgets of vegetated surfaces; qualitative and quantitative local differences in water vapor and carbon dioxide fluxes; water content of soils and vegetation; and depth and density of snow. Some implications of these measurements for understanding of ecological processes are discussed. Close collaboration between instrumentation engineers and field biologists is essential if best results are to be obtained. Author

N65-33623# General Technologies Corp., Alexandria, Va.
IDENTIFICATION AND ANALYSIS OF POSTATTACK EXPOSURE CONTROL COUNTERMEASURES Final Report
H. M. Childers and H. S. Jacobs 15 Jun. 1964 57 p refs (Contract OCD-PS-64-15)
(GTC-54-63-64; AD-460968)

An identification and analysis of postattack, exposure control countermeasures (except decontamination) are given relative to various postattack conditions. These countermeasures were found to fall into four general categories: control of population movement in fallout radiation fields, use of shielding for exposure control, control of radioactive material ingestion, and use of medical or chemical aids to counteract or control exposure. The analysis is concentrated on the first two categories. The interdependence of population control and shielding utilization appeared quite significant, and it was found that by controlling the size and configuration of a group of people an effective means of increasing the shielding afforded to all members is obtained. The analysis showed that the use of random mixing of the group members is always advantageous when the total accumulated dose is less than the mean value of the injury criteria. In all cases, close interval formations are superior to standard distance interval formation. C.T.C.

N65-33628* Yeshiva Univ., New York. Albert Einstein Coll. of Medicine.
SENSORY, PERCEPTUAL, AND PHYSIOLOGICAL ASPECTS OF SENSORY DEPRIVATION
Sidney Weinstein *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. D [1964] 25 p refs (See N65-33625 22-32)
(GRANT NsG-489)

The effects of sensory deprivation and their implications for space travel are discussed. Some of the more frequently used terms for sensory deprivation are defined, and a number of studies concerned with spatial disorientation, autokinetic effects, and size constance changes are presented. A study program to determine the lowest levels of impairment which may be responsible for the deficits obtained in sensory deprivation is outlined. It was demonstrated that informational feedback is of major importance for the achievement of visual adaptation. G.G.

N65-33629* National Aeronautics and Space Administration, Washington, D. C.
EFFECT OF LOW-GRAVITY ON PHYSIOLOGICAL PROCESSES.
Siegfried J. Gerathewahl *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. D [1964] 36 p refs (See N65-33625 22-32) CFSTI: HC $6.00/MF $1.25

The major problems involved in low-gravity experimentation with physiological systems are discussed, and available data of the effects of low-gravity states on physiological functions during or after orbital flights are evaluated in some detail. Although some neurophysiological and physiological functions of space fliers were affected by zero-G conditions, a certain adaptation of the major vital functions to the weightless condition was observed. Clinical and medical data obtained through postflight examinations showed generalized stress responses of the central nervous system, the cardiovascular system, and the metabolic system. The observed physiological disturbances of orthostatic hypotension, cardiovascular deconditioning, and demineralization of the body, receded after a few days and later disappeared completely. These occurrences of disturbances after relatively short flight durations, and their apparent dependence on the length of the low-gravity period, are of concern in future long-term mission planning. G.G.

N65-33630* Naval Air Development Center, Johnsville, Pa.
EFFECTS OF HIGH-GRAVITY ON PHYSIOLOGICAL PERFORMANCE
Randall M. Chambers *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. D [1964] 71 p refs (See N65-33625 22-32) CFSTI: HC $6.00/MF $1.25

The effects of high gravity on the physiological and psychological performance capabilities of man are summarized, and some of the major simulation studies on these aspects are reviewed. Physiological tolerance to high gravity evolved as a function of many variables. The type of G-protection used had a very important influence on the pilot's ability to tolerate acceleration, perform tasks, and maintain proficiency during acceleration stress. Most pronounced disturbances in all types of high acceleration occurred from shifts in the availability of arterial blood to the retina and resulted in visual disturbances. Other expressions of disturbances were: illusions of motion and position, lowered ability to sense changes in control characteristics, difficulties to perform tasks, reduced performance of the higher mental functions, and occurrences of emotional processes. G.G.

N65-33677# School of Aerospace Medicine, Brooks AFB, Tex.
A SELF-POSITIONING DEVICE FOR THE COLLECTION OF PAROTID FLUID FROM ISOLATED HUMAN SUBJECTS
Ira L. Shannon and James M. Terry Feb. 1964 8 p refs
(SAM-TDR-64-8; AD-433077)

A conventional metal cap for collecting parotid fluid has been fused to an acrylic biteblock to provide a device that can be quickly positioned and removed by the subject. This not only prevents cap dislodgment during sampling but also makes self-sampling possible in subjects who are exposed to long periods of isolation. Author

N65-33678# School of Aerospace Medicine, Brooks AFB, Tex.
TELUS (TELEMETRIC UNIVERSAL SENSOR)
William G. Glenn, Wesley E. Prather, and Heinz A. Jaeger May 1965 11 p refs
(SAM-TR-65-1; AD-468375)

There was need for a flexible complex of receiving and evaluating instruments for sensing physiologic and biologic analyses performed remotely by various field transducers. This need has been met by the design and development of TELUS (Telemetric Universal Sensor), a one-man laboratory console capable of receiving, quantitating, comparing, coding, storing, searching, retrieving, and distributing electrical and electromagnetic data. These data are received and distributed by radio and telephone. Field tests of TELUS indicate good performance characteristics for evaluating four channels of telemetered data and providing two-way communication between the laboratory and remote testing areas. Author

N65-33679# School of Aerospace Medicine, Brooks AFB, Tex.
THE EFFECT OF MASSIVE DOSES OF 32-MEV PROTONS AND CO^{60} GAMMA RADIATION ON SERUM ENZYME LEVELS OF WHOLE-BODY IRRADIATED PRIMATES
Glenn V. Dalrymple, Ian R. Lindsay, John J. Ghidoni, Harold L. Kundel, and Edwin T. Still May 1965 11 p refs
(SAM-TR-65-22; AD-468642)

Previous studies with 2-Mev x-irradiated primates have shown that significant elevation of serum lactic dehydrogenase (LDH) levels occurs after irradiation but that flutamic oxalacetic transaminase (SGOT) levels are essentially unchanged. In the present study, massive doses (6,500 to 6,700 rads) of 32-Mev protons and Co^{60} gamma radiation were given to primates (*Macaca mulatta*). Marked elevation of the serum levels of both of these enzymes occurred during the postirradiation period. Author

N65-33711*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
VARIATIONS IN INTRAUTERINE pH WITHIN A CIRCADIAN RHYTHM (GALLUS DOMESTICUS)
C. M. Winget, C. A. Mepham, and E. G. Averkin [1964] 26 p refs Submitted for Publication
(NASA-TM-X-51875) CFSTI: HC $2.00/MF $0.50 CSCL 06P

Data from Gallus Domesticus are presented showing the relationship between uterine pH and time post-oviposition. The data suggest that uterine pH is associated with certain periods of uterine activity. A Fourier analysis, a periodogram, and a correlogram all indicate a cyclic phenomenon; furthermore, the correlogram indicates the pH cycle to be endodiurnal. Author

N65-33738# School of Aerospace Medicine, Brooks AFB, Tex.
SMALL ANIMAL CENTRIFUGE FOR CHRONIC ACCELERATION STUDIES
Julian P. Cooke and Richard W. Bancroft May 1965 8 p refs
(SAM-TR-65-23; AD-468376)

A description is given of the construction and operation of a small animal centrifuge that has been devised especially for carrying out long-term, uninterrupted exposures to increased gravity fields. A nomogram is presented for ascertaining the effective gravity forces (g_E) in such a centrifuge in which suspended animal cages are allowed to align with vectorial forces. Author

N65-33752# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE DOCTOR PROPOSES, THE PHYSIOLOGIST INVESTIGATES AND THE CONSTRUCTOR CREATES
L. Kokin 15 Apr. 1965 20 p Transl. into ENGLISH from Nauka i Zhizn' (Moscow), no. 3, 1964 p 82–89
(FTD-TT-64-1089/1+2; AD-614946)

The development and descriptions of various bioinstruments for application to aerospace medicine are presented. These instruments include a cardiophone, a vector cardioscope, an electrocardiogram simulator, an intercom system for barometric chamber tests, and an electron voltage stabilization system. R.N.A.

N65-33755# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STUDYING ALBUMIN FRACTIONS OF THE BLOOD BY THE ELECTROPHORESIS METHOD OF CHRONIC MOUTH DISEASES
P. N. Andrianov 22 Jul. 1965 9 p Transl. into ENGLISH from Stomarologiya, (Moscow), no. 3, 1963 p 29–33
(FTD-TT-530/1+4; AD-618899)

The examined patients showed an increase in globulin content and reduction in albumin. This displacement becomes more pronounced with the duration of the illness, and with the rise in the histamine level of the blood serum. Repeated examination of patients after therapy showed that the state of albumin fractions improved, histamine level decreased, and general condition improved. TAB

N65-33801*# National Aeronautics and Space Administration, Washington, D. C.
RESULTS OF SOME MEDICAL INVESTIGATIONS ON THE SPACECRAFT VOSKHOD AND VOSKHOD 2 [REZUL'TATY NEKOTORYKH MEDITSINSKIKH ISSLEOVANIY NA KOSMICHESKIKH KORABLYAKH "VOSKHOD" I "VOSKHOD-2"]
O. G. Gazenko and A. A. Gyurdzhian May 1965 10 p Transl. into ENGLISH from RUSSIAN Presented at the 2d Ann. Meeting of the Am. Astronautics Soc., Chicago, 4–7 May 1965
(NASA-TT-F-9539) CFSTI: HC $1.00/MF $0.50 CSCL 06P

The report presents the results of some medical (chiefly physiological) investigations carried out during flights on the spacecraft Voskhod and Voskhod 2 which, according to the authors, amy be of interest in connection with the outlook for space travel, including manned flight to the moon. Author

N65-33806*# National Aeronautics and Space Administration, Washington, D. C.
POSSIBLE CARDIAC BEHAVIOR IN THE ABSENCE OF GRAVITY
Saul Kullock, Curt Mayer, and Samuel Kullok Sep. 1965 25 p refs Transl. into ENGLISH of "Sobre la Posible Conducta del Corazon en Ausencia de un Campo de Fuerzas Gravitatorias" (Buenos Aires), 1965 p 1–14
(NASA-TT-F-9562) CFSTI: HC $1.00/MF $0.50 CSCL 06P

The authors study the oxygen cardiac-energy equilibrium under various conditions. Methods for preventing and correcting cardiac deterioration in the absence of gravity are discussed. Author

N65-33809*# National Aeronautics and Space Administrstion, Washington, D. C.
A METHOD OF STUDYING THE AORTA BY DETERMINING THE SPEED OF PROPAGATION OF PULSE WAVES [K METODIKE ISSLEDOVANIYA AORTY OPREDELENIYEM SKOROSTI RASPROSTRANENIYA PUL'SOVOY VOLNY]
N. D. Reznik Oct. 1959 12 p refs Transl. into ENGLISH from Kardiologiya (Moscow), v. 3, 1963 p 78–81
(NASA-TT-F-9569) CFSTI: HC $1.00/MF $0.50 CSCL 06P

A method using simple equipment is presented for determining pulse wave velocity from pulse curve lag behind EKG. Pulse curve recording improves and pulse wave propagation time in the proximal segment of the aorta can be estimated. Comparison of propagation times reveals an atherosclerotic pathognomic ratio. Age changes have little and functional changes have no effect on the ratio. Author

N65-33830*# National Aeronautics and Space Administration, Washington, D. C.

AEROSPACE MEDICINE AND BIOLOGY—A CONTINUING BIBLIOGRAPHY, JULY 1965

Aug. 1965 143 p refs

(NASA-SP-7011(14)) CFSTI: HC $1.00/MF $1.00 CSCL 06E

An annotated bibliography is presented on aerospace medicine and biology. References are included on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the earth's atmosphere or in interplanetary space; similar effects on biological organisms of lower order; and related topics such as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors. R.N.A.

N65-33855*# Naval School of Aviation Medicine, Pensacola, Fla.

RESIDUAL EFFECTS OF STORM CONDITIONS AT SEA UPON THE POSTURAL EQUILIBRIUM FUNCTIONING OF VESTIBULAR NORMAL AND VESTIBULAR DEFECTIVE HUMAN SUBJECTS

Alfred R. Fregly and Ashton Graybiel 2 Jul. 1965 19 p refs Prepared jointly with NASA *Its* Rept.-115

(NASA Order R-93)

(NASA-CR-64935; NSAM-935) CFSTI: HC $1.00/MF $0.50 CSCL 06P

The residual effects of storm conditions at sea upon postural equilibrium functioning have not been studied objectively. As a part of a larger study, the opportunity was taken to investigate by means of a new quantitative ataxia test battery differences between vestibular normals (N=20) and labyrinthine defective (L-D) human subjects (N=9). Following a highly stressful sea experience, during which bizarre stimulation of the vestibular apparatus was amply provided, the L-D group maintained or improved their baseline postural equilibrium test performance scores. The ten initially poorest scoring normals as a subgroup were found free of postural decrement in contrast with significant performance decrements observed in the initially highest scoring subgroup of normals. Probable influences over differential results within the normals and between groups as well as differential test findings are discussed. Author

N65-33865*# Naval School of Aviation Medicine, Pensacola, Fla.

TISSUE DOSAGES FROM ALPHA PARTICLES AND HEAVY NUCLEI IN SOLAR PARTICLE BEAMS IN SPACE

Hermann J. Schaefer 17 Jun. 1965 15 p refs Prepared jointly with NASA *Its* Rept-32

(NASA Order R-75)

(NASA-CR-64997; NSAM-933) CFSTI: HC $1.00/MF $0.50 CSCL 06R

Recordings of several large flare events indicate that solar particle beams contain, in addition to H and He, also heavy nuclei. For the November 13, 1960 flare in particular, complete rigidity spectra for H and He and C, N, O, F nuclei have been reported. Evaluation of these spectra in terms of tissue depth doses behind 0.1 g/cm^2 shielding shows that, while the He component contributes substantially to exposure in near-surface regions, the dose function of the medium heavy component remains, even in the tissue surface, on the level of a few percent. In view of the smallness of this contribution, it seems unnecessary to extend the spectral resolution of LET sensors up to the Bragg peaks of medium heavy nuclei (1000 kev/micron T). Author

N65-33921*# Naval School of Aviation Medicine, Pensacola, Fla.

SYMPTOMATOLOGY UNDER STORM CONDITIONS IN THE NORTH ATLANTIC IN CONTROL SUBJECTS AND IN PERSONS WITH BILATERAL LABYRINTHINE DEFECTS

Robert S. Kennedy, Ashton Graybiel, Robert C. Mc Donough, and Frederick D. Beckwith 25 May 1965 15 p refs

(NASA Order R-93)

(NASA-CR-64879; NSAM-928) CFSTI: HC $1.00/MF $0.50 CSCL 06P

Ten labrinthine defective (L-D) and twenty normal subjects were exposed to extremely severe weather conditions during a sea voyage. The effects of such a stress were complicated by a feeling of fear in all of the normal and in some of the L-D subjects. None of the latter manifested typical symptoms of motion sickness whereas all of the normal subjects did. The fact that the L-D subjects did not become sick suggests that, even in instances where motion sickness symptoms appear to be triggered by anxiety, the vestibular organs play an essential etiological role. Author

N65-33950*# National Aeronautics and Space Administration, Washington, D. C.

AVIATION MEDICINE

A. A. Lavnikov Sep. 1965 251 p refs Transl. into ENGLISH of the book "Aviats. Med." Moscow, Voyenizdat, 1961

(NASA-TT-F-8403) CFSTI: HC $6.00/MF $1.50 CSCL 06E

A Soviet manual on anatomical, hygienic, and physiological problems in aviation is presented which is addressed to aviation personnel. This textbook is of interest primarily for evaluation of Soviet Air Force personnel training and the presentation of popular ideas concerning passive defense against nuclear attack. J.M.D.

N65-33951*# National Aeronautics and Space Administration, Washington, D. C.

SYNTHETIC ELECTROCARDIOLOGY

Z. L. Dolabchyan Jan 1965 402 p refs Transl. into ENGLISH of the book "Sintetich. Elektrokardiologiya" Yerevan, Armenian SSR Acad. of Sci. Publishing House, 1963

(NASA-TR-F-9459) CFSTI: HC $7.00/MF $2.00 CSCL 06P

The author, on the basis of his own experience in a modern cardiological clinic using electrophysiological and biophysical methods of heart study, approaches these methods from a single viewpoint. This is accomplished by passing from the analytic examination of each investigative method to a synthesis of all these methods. In this work, the questions pertaining to modern clinical electrocardiology are investigated on the basis of a synthetic principle. This monograph is, in fact, a first attempt at defining clinical electrocardiology as a separate branch of cardiology. The book is intended for electrocardiologists, practicing physicians, surgeons, and physiologists working in the domain of clinical and experimental cardiology. There is a concise English annotation at the end of the book. Author

N65-33958*# National Aeronautics and Space Administration, Washington, D. C.

SOME PROBLEMS IN ECOLOGICAL PHYSIOLOGY

N. M. Sisakyan Sep. 1965 14 p Transl. into ENGLISH of "Nekotoryye Problemy Ekofiziologii", Akad. Nauk SSSR (Moscow)

(NASA-TT-F-9545) CFSTI: HC $1.00/MF $0.50 CSCL 06P

The author enumerates some problems of space physiology still to be solved. Comprehensive study of the effect of

environmental factors and their actions has led to the formulation of ideas on physiological methods of increasing the resistance of man, and to the recommendation of techniques for protection of man against injurious environment factors.
Author

N65-33991# Brookhaven National Lab., Upton, N. Y.
MECHANISM OF THE IMMUNE RESPONSE Brookhaven Lecture Series No. 42, Dec. 1964
Marian Elliott Koshland Aug. 1965 20 p refs
(BNL-912 (T-374)) CFSTI: $1.00

The mechanism of the human body's immune response when a foreign substances gains entrance to the tissues is discussed. Some of the classic examples of pathogenic viruses, bacteria, and bacterial products, as well as examples of the many foreign substances other than invading microorganism are listed. The sequence of events describing the cellular reaction when an individual has his first contact with a foreign substance is outlined, and the physicochemical properties and structure of antibody in general are presented. Reexamination of the amino acid composition of several rabbit antibodies established an over-all similarity of the compositions, and also the appearance of a few small but significant differences. It was concluded that antibody synthesis is directed by information contained in the genetic apparatus of the cell.
G.G.

N65-34001*# United Aircraft Corp., Windsor Locks, Conn. Space and Life Systems Dept.
MEDICAL AND BIOLOGICAL APPLICATIONS OF SPACE TELEMETRY Technology Utilization Report
Washington, NASA, Jul. 1965 70 p refs Sponsored by NASA (NASA-SP-5023) GPO: $0.45; CFSTI: MF $0.75 CSCL 06B

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N65-34002* Cox Coronary Heart Inst., Dayton, Ohio.
PRACTICAL PROBLEMS OF USING TELEMETRY IN INTENSIVE-CARE WARDS
G. Douglas Talbott *In* United Aircraft Corp., Windsor Locks, Conn. Med. and Biol. Appl. of Space Telemetry Jul. 1965 p 5–10 refs (See N65-34001 22-04) GPO: $0.45; CFSTI: MF $0.75

The place of telemetry in intensive-care wards is assured. By means of telemetry, the status of the acutely ill patient can be constantly monitored and assessed. The introduction of this technology into clinical medicine will force increasing attention to the problems of "processing" the data so that ward personnel are not overwhelmed by the output of the system. The use of telemetry at the Cox Coronary Institute is discussed in this chapter.
Author

N65-34003* United Aircraft Corp., Windsor Locks, Conn.
TELEMETRY IN SURGERY AND ANESTHESIOLOGY
M. S. Molnar *In its* Med. and Biol. Appl. of Space Telemetry Jul. 1965 p 11–15 (See N65-34001 22-04) GPO: $0.45; CFSTI: MF $0.75

Something of a delemma has been created in surgery. Research and advanced techniques now allow surgery in many marginal situations previously considered hopeless. In these cases, the surgeon and anesthesiologist are pressed to keep sufficiently informed of the patient's condition. Continuous monitoring and warning signals provided by biotelemetry are of ever increasing assistance. The synthetic environment common to astronautics and surgery may be the key to improved interchange of knowledge between these areas. This chapter examines reasons for the recent change in surgical monitoring techniques, showing the role that technological advancement in nonmedical fields has played in bringing about the change. It relates the impact that space technology in particular has had and may have on the methods used to telemeter patient conditions during surgery. To discover some of the advances in surgical and anesthetic practices which may arise from space age technology, the need for improved patient monitoring is outlined, and the history of surgical monitoring systems is traced.
Author

N65-34004* United Aircraft Corp., Windsor Locks, Conn. Hamilton Standard Div.
DIAGNOSTIC MONITORING IN OFFICE PROCEDURE
P. R. Amlinger *In its* Med. and Biol. Appl. of Space Telemetry Jun. 1965 p 17–21 (See N65-34001 22-04) GPO: $0.45; CFSTI: MF $0.75

Biotelemetry as the electrical transmission of biological data for the preservation of life has been classified according to its functional conditions in monitoring normal life in normal or abnormal environments and abnormal life in normal environments. However, such groupings may be overlapping. Although this chapter is concerned mainly with the observation of normal life in office procedures, where the environment can be called normal, it still requires dealing with (usually) normal life under some unusual conditions.
Author

N65-34005* Stanford Univ., Calif. School of Medicine.
TELEMETRY AND TELESTIMULATION IN PSYCHOPHYSIOLOGY
B. Robinson *In* United Aircraft Corp., Windsor Locks, Conn. Med. and Biol. Appl. of Space Telemetry Jul. 1965 p 23–32 refs (See N65-34001 22-04) GPO: $0.45; CFSTI: MF $0.75

Telestimulator systems can be used in conjunction with telemetry devices so that physiological responses of subjects receiving electric stimulation of the brain can be remotely observed. Three such telestimulator-telemetry systems are discussed in this chapter. The first of these are the MARK I and II systems. The third system is under construction by the United Aircraft Corporation with support from NASA. System characteristics, psychophysiological applications, space applications, and possible medical uses for such systems are also discussed. The purpose of this chapter is to review, concisely and clearly, the techniques currently available for remote brain stimulation and recording. The emphasis will be consistently on general principles; the reader interested in the details can refer to the bibliography for access to the literature. The possible uses of these techniques will then be discussed. A large part of this

chapter is frankly speculative and projects into the future, for the field is barely newborn. Yet, in an age when the future is barely realized before becoming obsolete, such a projection may have its justification. Author

N65-34068# Florida Univ., Gainsville. Dept. of Physiology.
HYPOXIC LACTACIDEMIA: ITS PREVENTION WITH HEPARIN
Edward Otey Brooks AFB, Tex., School of Aerospace Med., Dec. 1964 13 p refs Submitted for Publication
(Contract AF 41(609)-1553)
(SAM-TR-64-78; AD-457902)

Thirteen anesthetized dogs were treated with heparin (5 to 7 mg./kg.), and 10 were treated with another anticoagulant (Mepesulfate, 50 mg./kg.). All breathed low oxygen gas mixtures after a control period during which they breathed air. Lactic acid and excess lactate in arterial blood increased in an almost linear fashion in the animals given Mepesulfate, but no increase in either substance was seen in heparin-treated animals. These results indicated that a re-evaluation of the role heparin plays in physiologic functions is necessary. Author

N65-34102# Joint Publications Research Service, Washington, D. C.
REGULATIONS PERTAINING TO WORK WITH IONIZING RADIATION SOURCES
14 Sep. 1965 25 p Transl. into ENGLISH from Sluzbeni List SFRJ (Belgrade), no. 31, 14 Jul. 1965 p 1198–1205
(JPRS-31993; TT-65-32487) CFSTI: $1.00

The regulations for handling radioactivity in Yugoslavia are presented. These include: (1) The health conditions and physical examination requirements for persons who work with ionizing radiation sources. (2) The maximum permissible doses of ionizing radiation to which workers may be exposed. (3) The professional training requirements of persons working with ionizing radiation sources, and the protection procedures against such radiation. (4) The use of radioactive materials in excess of the maximum limits of activity, and the protective measures against radiation from such sources. W.M.R.

N65-34107# Brookhaven National Lab., Upton, N. Y.
RADIATION AND THE PATTERNS OF NATURE
George M. Woodwell 24 Mar. 1965 19 p refs *Its* Lecture Ser. No. 45 Sponsored by AEC
(BNL-924(T-381)) CFSTI: $1.00

The patterns of radiation effects on natureal communities, and the normal patterns of structure, function, and development of these communities are considered. The approach used involved the establishment of two experiments. A single large source of gamma radiation was arranged so that it could be lowered into a shield to allow safe approach to the source, or suspended several feet above the ground to provide a large radiation field. The sources were large enough to give exposures of several thousand roentgens per day within a few meters, dropping to near background levels at distances > 300 m. The two experiments were in an irradiated old field in a well-known gamma radiation field, and in a newly irradiated forest. Irradiation produced striking changes in the communities of the early successional stages. The most conspicuous change was a drastic simplification or a reduction in numbers of species per unit area or diversity. Irradiation at 1000 R/day reduced diversity to ≈ 50% as compared to the nonirradiated field 2 km distant. The forest did not share the plasticity of communities with simpler structures and, in that respect, was more sensitive to any disturbance. R.W.H.

N65-34134# St. Louis Univ., Mo. Dept. of Physiology.
CONTINUOUS REGISTRATION OF BODY WEIGHT Final Report, May 1963–Sep. 1964
Alrick B. Hertzman, Franz Flath, Bernell Coleman, and Louis S. D'Agrosa Wright-Patterson AFB, Ohio, AMRL, Jun. 1965 15 p refs
(Contract AF 33(657)-11551; Grants PHS-H-4939; PHS-HE-07070)
(AMRL-TR-65-23; AD-619441)

This report describes a device for continuous recording of the weight of a human subject. The frame on which the subject may either sit or lie is carried by three load cells mounted as a tripod. The electrical signals from the strain-gauges permit detection of a weight change of one gram. Insulation and heating of the load cells to a constant temperature ±0.1° C permit use of the system in the presence of rapid changes in environmental temperatures. Circuits are described for automatic regulation of load cell temperature. Author

N65-34145# Air Force Systems Command, Kirtland AFB, N. Mex. Air Force Weapons Lab.
AVERAGE RANGES AND MEANS OF BLOOD VALUES IN NEW MEXICO BRED SHEEP UNDER SPECIFIED ENVIRONMENTAL CONDITIONS Technical Report, Oct. 1963–May 1965
Norman D. Jones, Robert K. Jones, and William R. Godden Aug. 1965 28 p refs
(AFWL-TR-65-109; AD-619649)

This paper reports normal hematologic values of a large number of sheep under known and stated conditions. Seven hundred ninety-four samples from 336 Rambouillet-Columbia-cross sheep 18 to 36 months of age were taken over a period of 20 months. Monthly ranges, averages, and one standard deviation are reported for erythrocytes, leucocytes, thrombocytes, differential counts, hemoglobin, hematocrit, mean corpuscular volume, and mean corpuscular hemoglobin concentration. Altitude appears to affect some of these values. Author

N65-34185# Göttingen Univ. (West Germany). Inst. for Plant Physiology.
DIAMINODUREN AS ELECTRON DONOR AND THE EFFECT OF UV-LIGHT ON PHOTOSYNTHETIC REACTIONS IN ISOLATED CHLOROPLASTS Scientific Report No. 2
A. Trebst 1 May 1965 12 p refs
(Contract AF 61(052)-716)
(AFCRL-65-550; AD-619822)

Diaminoduren reverses the DCMU-inhibition of photosynthetic NADP-reduction and therefore acts as electron donor for the electron transport chain. The DAD-system is coupled to ATP-formation and gives the best rates of all electron donor systems known so far. In UV-irradiated chloroplasts the endogenous plastoquinone is destroyed. Such chloroplasts do not evolve oxygen anymore, but are still able to photoreduce NADP at the expense of an artificial electron donor system. Cyclic photophosphorylation with PMS as cofactor is less sensitive to UV-irradiation and at a certain stage of damage of the chloroplasts becomes inhibited by antimycin; indicating a second phosphorylation site. Author

N65-34204# Library of Congress, Washington, D. C. Aerospace Technology Div.
BIOLOGICAL EFFECTS OF MICROWAVES Surveys of Soviet Scientific and Technical Literature
17 Sep. 1965 100 p Compilation of Abstracts
(ATD-P-65-68)

An annotated bibliography which was designed to review the historical development and to survey the contemporary

state of Soviet and Soviet-Bloc research on the biological effects of microwaves, especially in the radio frequency ranges, is reported. Abstracts are based primarily on literature published during the period 1937 to 1965. Focused on were those articles concerned with the effects of microwaves on the central nervous system. Data are presented in the following areas: hygienic and clinical aspects of microwaves, experimental effects of microwaves, and the effects of a constant magnetic field and low-frequency electromagnetic fields on higher nervous activity. Included are discussions and reviews on biological effects, experimental methods, and mechanisms of the action of microwaves. S.C.W.

N65-34205# Brookhaven National Lab., Upton, N. Y.
1963 ENVIRONMENTAL RADIATION LEVELS AT BROOKHAVEN NATIONAL LABORATORY
A. P. Hull Nov. 1964 20 p refs
(BNL-915(T-376)) CFSTI: $1.00

Natural background and radiation levels attributable to Laboratory operations during 1963 are summarized. Record amounts of fallout, principally from the atmospheric testing of nuclear weapons by the USSR during the latter part of 1962, were also observed in many types of environmental samples, and data on fallout radioactivity levels are reported. Also included are data on external wholebody exposures, air particulate concentrations, rain and settled dust collections, milk and vegetation concentrations, and liquid effluent and offsite stream concentrations. S.C.W.

N65-34227*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
ANALYSIS OF THE EXTRATERRESTRIAL LIFE DETECTION PROBLEM
Richard S. Young, Robert B. Painter, and Richard D. Johnson Washington, NASA, 1965 36 p refs
(NASA-SP-75) CFSTI: HC $2.00/MF $0.50 CSCL 06M

Some guidelines and ground rules relating to the detection of evidences of extraterrestrial life and to the development of instrumented payloads for specific planets are considered. The attributes of life are discussed in terms of macromolecules, metabolism, and reproduction; and it is emphasized that any detection system should include experiment dealing with all these attributes. Results from chemical experiments alone, even if they indicate the existence of compounds such as proteins or nucleic acids, do not necessarily indicate the existence of life. A discussion of Mars and the problems encountered there deals with life detection sampling, optimum experimental configurations, and mission profile after landing. Sterilization problems and techniques are also considered. M.W.R.

N65-34260# School of Aerospace Medicine, Brooks AFB, Tex.
THE EFFECT OF AET ON THE IN-VITRO OXIDATION OF GLUCOSE BY RAT SPLEEN AND BONE MARROW SUSPENSIONS
Harold L. Kundel and Donald F. Logsdon, Jr. May 1965 7 p refs Submitted for Publication
(SAM-TR-65-29; AD-468463)

The effect of AET injected intraperitoneally (200 mg./kg.) and added in vitro on the oxidation of glucose by spleen cell and bone marrow suspensions has been studied. No significant effect could be demonstrated. Author

N65-34281# Northrop Space Labs., Hawthorne, Calif.
A LONG RANGE AND CONTINUING SEARCH FOR CHANGES IN BIOLOGICAL SYSTEMS RESULTING FROM DAMAGE INDUCED BY IONIZING RADIATIONS Formal Progress Report, 1 Nov. 1964–28 Apr. 1965
J. A. Demetriou and F. M. Maciasr 30 Apr. 1965 14 p
(Contract AF 41(609)-2679)
(NSL-65-23-1; AD-464998)

Urine collected from rats exposed to a total dose of about 805 ± 81 rads was analysed for fluorescent products by means of gel filtration. Using a 15 cm gel filtration column and water as the elutant, compounds such as vanillymandelic acid, 3-methoxy-4-hydroxy-phenyl acetic, and 3-methoxy-4-hydroxy-phenyl glycol were eluted. Utilization of sodium chloride as eluting solution resulted in the separation of ephinephrine, normetanephrine, and serotonin. Chromatography of native urine of the gel columns showed multiple sharp fluorescent peaks of proteins, and several pigmented fractions. It was concluded that the present fluorometer arrangement is not practical for obtaining a complete chromatographic profile of fluorescent fractions in the urine. G.G.

N65-34303# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
ADAPTATION TO VESTIBULAR DISORIENTATION. II: NYSTAGMUS AND VERTIGO FOLLOWING HIGH-VELOCITY ANGULAR ACCELERATIONS
William E. Collins Sep. 1965 12 p refs
(AM-65-24)

Professional figure skaters who, as part of their daily routine, subject themselves to high levels of disorientation- and vertigo-producing stimuli, were given a series of laboratory tests consisting primarily of caloric irrigations and mild angular accelerations. Electronystagmographic recordings and subjective reports (turning sensations and vertigo) were obtained. Contrary to other reports, brisk vestibular responses were obtained, prompting an "on-ice" study employing telemetry of eye movements to an ENG recorder and motion pictures. Data were obtained during and following normal high-velocity spins on ice. In the absence of opportunities for visual fixation, vigorous nystagmus and disorientation occurred. Thus, even with highly trained subjects, vestibular stimulation can produce disorientation when visual cues are not present. Author

N65-34314# Rochester Univ., N. Y.
PLATELET SIZE DISTRIBUTION FOLLOWING X-IRRADIATION
R. O. Spertzel, T. J. Bucci, and M. Ingram 19 Apr. 1965 11 p Presented at the 2d Intern Congr. of Radiation Res., Harrogate, England, 5–11 Aug. 1962
(Contract W-7401-ENG-49)
(UR-663; CONF-19-5)

The effect of X-ray irradiation on blood platelet size was evaluated quantitatively. Microscopic examination of stained blood films indicates that platelet size becomes irregular in dogs during recovery from single large X-ray doses, and in men receiving low-level exposures over long periods. J.M.D.

N65-34316# California Univ., Los Angeles.
EFFECTS OF CHELATED IRON AND ZINC ON ROUGH LEMON AND TRIFOLIATE ORANGE SEEDLINGS GROWN IN CALCAREOUS AND NONCALCAREOUS SOIL
A. H. Khadr, A. Wallace, and E. M. Rommey [1964] 9 p refs
(Contract AT(11-1)-34)
(TID-20741)

Trifoliate orange seedlings were zinc deficient when grown on noncalcareous soil or calcareous soil, and they were severely injured by iron chlorosis when grown on calcareous soil. Rough lemon was not subject to these deficiencies when grown on either soil. ZnEDTA amendment corrected both Zn and Fe deficiencies and FeEDDHA corrected Fe deficiency. Among those factors observed in trifoliate orange which might

have contributed to its susceptibility for Fe and Zn deficiencies were the high P, high K, and high Ca contents in leaf tissue compared to the low content of these elements in rough lemon which has a high degree of resistance to Fe and Zn deficiencies. Author

N65-34320# Florida State Univ., Tallahassee. Dept. of Chemistry.
COPPER PROTEINS AND OXYGEN; CORRELATIONS BETWEEN STRUCTURE AND FUNCTION OF THE COPPER OXIDASES
Earl Frieden, Shigemasa Osaki, and Hiroshi Kobayashi (Harvard Univ.) 15 May 1965 45 p refs *Its* Bull. No. 21
(Grant PHS-HE-08344)
(FSU-2690-21)

A comprehensive survey of the interaction of the copper proteins and oxygen is presented, including a correlation of structure, function and other properties of the known copper oxidases and of hemocyanin. The oxygen reactions of hemocyanin, ceruloplasmin and cytochrome oxidase show half-saturation values far below the other Cu enzymes. The formation of hydrogen peroxide as a reaction product is associated with the presence of one Cu atom per oxidase molecule or catalytic system. Water is the corresponding product of the other Cu oxidases with four or more Cu atoms per molecule, except for monamine oxidase. Mechanisms for the oxidase action of the two and four electron transfer Cu oxidases and tyrosinase are proposed. These reactions account for the number, the oxidation-reduction potential and the oxidation state of Cu in the resting enzyme, the cyclical change from Cu(II) to Cu(I), the diatomic nature of O_2, the sequence of the oxidation and reduction reactions and other salient features. The catalytic reactions involved in the oxidation of ascorbic acid by plant ascorbate oxidase, ceruloplasmin and Cu(II) are compared. Finally the substrate specificity, inhibitory control and the detailed mechanism of the oxidase activity of ceruloplasmin are summarized. Author

N65-34324# California Univ., Davis. School of Veterinary Medicine.
THE EFFECTS OF X-IRRADIATION ON WORK CAPACITY AND LONGEVITY OF THE DOG Annual Progress Report No. 14
A. C. Andersen Apr. 1965 78 p
(Contract AT(04-3)-472)
(UCD-472-111)

The effects of total body X-irradiation on the reproduction in the female Beagle dog were studied. It was found that the ability of the female to procreate was not seriously affected by a single total body exposure. Fractionated exposures at weekly intervals at the rate of 50 rad per week for a total of 750 rad sterilized the female dogs partially or possibly completely. The reproductive ability of control dogs reached maximum at 3.4 years of age. The ability of dams to lactate was decreased by irradiation. Available information suggests that an endocrine dysfunction is responsible for this long-term radiation effect. Losses total 57% with 75 out of 200 deaths due to neoplasms. Neoplasms of the reproductive system ranked highest (33%) with lung cancer ranking second. The pathogenesis of these neoplasms is under investigation. The 154 dogs remaining in the experiment now average 10.7 years of age. Aging is apparent in waning general appearance and decreased physical activity. Fifty-two percent of the dogs have mammary tumors, the malignant counterpart of which is a major cause of death. Case histories, gross autopsy results, and histology data are included. E.E.B.

N65-34417# School of Aviation Medicine, Randolph AFB, Tex.
A STUDY OF SOME FACTORS RELATED TO QUANTITATIVE DETERMINATIONS BY IMMUNOELECTROPHORESIS
Warren J. Russell Dec. 1964 13 p refs
(SAM-TR-64-92; AD-461346)

Factors involved in determining antigen concentration by relating immunoelectrophoretic precipitin arc position to the origins of antigen and antibody have been analyzed by using refined immunologic systems. A highly significant linear relationship exists when the p value (diffusivity ratio) is regressed on the log antigen concentration for both albumin and γ-globulin. Statistical analysis showed that the p value difference must exceed 0.075 for albumin-antialbumin and 0.059 for γ-globulin-anti-γ-globulin before any significant difference can be declared at the .05 level. Experimentally determined equivalence and theoretic equivalence p values were compared. The observed differences were attributed to a decrease in peak antigen concentration as the antigen is moved in the electrical field. An experimental design, based on the data in this report, is presented for predicating unknown antigen concentration by immunoelectrophoresis. Author

N65-34428*# National Aeronautics and Space Administration, Washington, D. C.
THE STATE-OF-THE-ART OF ELECTROENCEPHALOGRAPHY AND ITS ROLE IN MANNED SPACE FLIGHT
J. F. Herrick 21 Jun. 1965 21 p refs
(NASA-TM-X-57000) CFSTI: HC $1.00/MF $0.50 CSCL 06E

A collection of opinions from scientists in the fields of neurophysiology and electroencephalography is presented on the state-of-the-art of the electroencephalogram (EEG) for determining the competency of man during orbital space flight. Since competency is defined as functional adequacy, some clue to this adequacy may be found in monitoring the nervous system, particularly the electrical activity of the brain. The Soviet open literature contains information obtained from EEG's recorded during several flights of cosmonauts by placing silver electrodes on the forehead and occiput. The objective in studying the EEG's was to search for a relationship between particular variations in the EEG measurements and the overall condition of the cosmonaut in orbital flight R.R.D.

N65-34453# Joint Publications Research Service, Washington, D. C.
CELLULAR BIOLOGY
S. Ye. Severin et al 15 Sep. 1965 26 p Transl. into ENGLISH of articles from Vestn. Akad. Nauk SSSR (Moscow), no. 7, Jul. 1965 p 42–58, 94–95
(JPRS-32016; TT-65-32510) CFSTI: $2.00

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1. ACTIVE MAINTENANCE OF PHYSIOLOGICAL FUNCTIONS S. Ye. Severin p 1–21
2. STRUCTURE AND FUNCTION OF BIOLOGICAL MEMBRANES N. S. Gel'man and M. A. Lukoyanova p 22–24

N65-34461*# California Univ., Berkeley. Space Sciences Lab.
A THEORETICAL AND EXPERIMENTAL STUDY OF THE MECHANICAL BEHAVIOR OF THE CORNEA WITH APPLICATION TO THE MEASUREMENT OF INTRAOCULAR PRESSURE
Nathan Jay Schwartz 28 Jul. 1965 110 p refs *Its* Ser. No. 6, Issue No. 31
(Grant NsG-600)
(NASA-CR-67160) CFSTI: HC $4.00/MF $0.75 CSCL 06P

A theoretical and experimental study was made of the mechanical behavior of the cornea. The theoretical analysis included an analytical solution for the symmetrical constraint of a thin, shallow, spherical shell by a rigid indenter. The experimental study investigated the rheology of the cornea with particular emphasis on its compliance with the requirements of the Boltzmann superposition principle. Representative results of tests on twenty enucleated hog eyes and two human eyes have been reported. The corneas of the human and hog eyes behaved as linear viscoelastic solids; the human eyes differed from the hog eyes in having a long term creep component. Several eyes were tested at the site of procurement, six to seven minutes after the animal's death, and it was established that creep is not an artifact due to aging or enucleation. The analytical and experimental results were combined to study some instruments used to detect the level of pressure in the eye. The theoretical analysis predicted that a type of elastic instability occurs during the process of flattening a small portion of the cornea; this is discussed with reference to the Goldmann and Mackay–Marg tonometers. The role of corneal creep was considered with reference to the response of the Schiotz indentation tonometer during the time dependent process known as tonography. Author

N65-34467# Naval Air Development Center, Johnsville, Pa. Aviation Medical Acceleration Lab.

A CLINICAL TEST OF NOREPINEPHRINE DEPLETION Progress Report

K. R. Brown and O. E. Payne 22 Jun. 1965 16 p refs

(NADC-ML-6511; AD-469350)

1. Determination of changes in forearm vascular resistance, before and after painful stimuli (such as the cold pressor test) is a useful test of norepinephrine depletion. 2. Reserpine causes effective depletion of norepinephrine, in healthy individuals in relatively small doses (4.0 mg given in divided doses over a 10-day interval). 3. It appears that norepinephrine depletion may result from any of the following: (a) treatment with antihypertensive medications such as reserpine; (b) prolonged treatment with sympathomimetic drugs; (c) congestive heart failure; (d) prolonged or severe exercise; (e) cerebrovascular accident in a hypertensive patient; (f) prolonged weightlessness. 4. Several clinical problems involving norepinephrine depletion have been presented, along with consideration of the possibility of its occurrence during manned flight. Author

N65-34492# Boyce Thompson Inst. for Plant Research, Inc. Yonkers, N. Y.

GROWTH OF TISSUES OF HIGHER PLANTS IN CONTINUOUS LIQUID CULTURE AND THEIR USE IN A NUTRITIONAL EXPERIMENT Technical Report, 1 Jan. 1964–30 Apr. 1965

Walter Tulecke Wright Patterson AFB, Ohio, AMRL, Jul. 1965 47 p refs

(Contract AF 33(616)-1355)

(AMRL-TR-65-101; AD-620047)

The purpose of this work was twofold: (1) to devise a continuous culture system for higher plant cells; and (2) to produce a sufficient amount of plant tissue culture for a nutritional experiment with weanling mice. The overall purpose of this work is to provide information for the evaluation of plants as food sources in long term space missions and as possible future sources of supplementary protein. Rose tissue was the most suitable for growth in liquid culture and approximately 40 pounds (20 kg) fresh weight of sterile tissue was produced from seven cultures which were harvested periodically over a period of 222 days. The cultures were of 8 liters volume and this amount was maintained by replacing the medium which was harvested. The average yield was 112 g/l fresh weight (4.6 g/l dry weight)/day. Approximately 10 pounds (5.0 kg) of contaminated rose tissue was also produced. When incorporated into a test diet for weanling mice, the sterile rose tissue was a better food supplement than contaminated rose. A bacterial contaminant which grew well with the rose tissue and did not appreciably alter the growth rate was isolated and identified as *Achromobacter liquefaciens*. Author

N65-34507*# National Aeronautics and Space Administration, Washington, D. C.

NORMAL DURATION OF THE ELECTRIC SYSTOLE IN MAN

Ye. B. Babskiy, V. L. Karpman, and I. N. Ivanitskaya Oct. 1965 9 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 156, no. 6, 1964 p 1472–1475

(NASA-TT-F-264) CFSTI: HC $1.00/MF $0.50 CSCL 06P

The relationship between the duration of the electric systole and the cardiac rhythm was studied through analyses of 307 electrocardiograms from 186 men and 121 women, both groups between the ages of 17 to 59 years. All observations were divided into 7 groups, and the mean duration of the cardiac cycle, as well as of the electric cycle was computed for each group. Individual values of the duration of the Q-T interval were compared with those calculated from equation:

$$S_e = 0.383 \sqrt[3]{C},$$

where C is the cardiac cycle. A fluctuation within the limits of ±0.04 seconds was found for the observational values. The electric systole lasted about 0.01 seconds longer in women than in men; but no increase of the Q-T interval in relation to age was established. G.G.

N65-34515# School of Aviation Medicine, Brooks AFB, Tex.

SOME OBSERVATIONS OF THE CLINICAL MANAGEMENT OF THE CHIMPANZEE

Ethard W. Van Stee Nov. 1964 49 p refs

(SAM-TDR-64-45; AD-457081)

The first section describes the etiology, pathology, pathogenesis, diagnosis, and clinical management of infectious enteritis in the chimpanzee. The second section describes in detail the theory and practice of fluid and electrolyte deficit and maintenance therapy as applied to the chimpanzee. The methods described are adapted from the general techniques of Pickering and Hardy. The third section contains eight typical case histories and conclusions. The cases are not exhaustive; rather, they represent a few of the more common problems encountered in the management of a chimpanzee colony. Author

N65-34517# Army Medical Research and Nutrition Lab., Denver, Colo.

COMPARISON OF MINERAL EXCRETION (CALCIUM AND IODINE) IN ARM AND TOTAL BODY SWEAT

C. Frank Consolazio, LeRoy Q. Matoush, Richard A. Nelson, Gerhard J. Isaac, and Ronald C. Hughes 14 Aug. 1964 16 p refs

(Rept.-282; AD-447380)

Calcium and iodine excretions calculated from arm sweat samples are in fairly close agreement with those calculated from total body sweat samples, but total body sweat excretion is considered the better indicator of mineral excretion. Calcium excretion from total body sweat ranged from 71 to 76% of that obtained from arm sweat. Both calcium and iodine excretion decreased during sleeping hours when the sweat rate is approximately one-half that found during periods of activity. M.W.R.

N65-34581* Argonne National Lab., Ill.
METHODS IN THE EVALUATION OF RADIATION HAZARDS IN MANNED SPACE FLIGHT
Douglas Grahn and Wright H. Langham (Los Alamos Sci. Lab.) *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 59–64 refs Prepared jointly with Los Alamos Sci. Lab. Sponsored by AEC (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Early incapacitation, progressive incapacitation, and chronic injury are considered in a discussion of radiation hazards in manned space flights. Limiting systemic and/or tissue responses which result in immediate or early incapacitation are acute gastrointestinal and hematopoietic symptomatologies, widespread erythema and blistering, and degradation of general operational skills or reduced performance capacity. The above responses, which require emergency or abort dose determination, should be examined in a probabilistic manner. Progressive incapacitation, resulting principally in hematopoietic injury, follows fractionated or protracted exposures. An equivalent residual dose concept, which has not been validated in man, may have use in cases where injury level does not affect the recovery mechanisms. A simple unweighted dose accumulation may be of value in cases with higher daily doses and fractionated exposures. Chronic or long-term effects of radiation exposure, which are considered of secondary importance in the evaluation of hazards of manned flights, require a dose accumulation measure. M.W.R.

N65-34582* Oak Ridge National Lab., Tenn.
LETHAL, MUTAGENIC, AND CYTOGENETIC EFFECTS OF FAST CHARGED PARTICLES ON VARIOUS BIOLOGICAL MATERIALS
G. E. Stapleton *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 65–71 refs (See N65-34575 22-29) GPO: $3.25 CFSTI: MF $2.50
(NASA Order R-104)

Ground-based investigations of cellular responses to high energy protons and heavy particles were performed to determine lethal, mutagenic, and cytogenetic effects on various biological materials. Data obtained for *Escherichia coli* indicate the inactivation coefficient for aerobic cells changes significantly only for the high linear energy transfer (LET) carbon ions. Anaeroebic cells exhibit a higher relative biological effectiveness (RBE) for 22 MeV protons and heavy carbon ions than for other radiations. Protons of 100 to 750 MeV exhibit the same mutagenic effects as X-rays. The RBE's for cellular inactivation and mutation in neurospora, and of different radiation on gametogenesis in the mouse, are tabulated. Coefficients of chromosomal aberration production for proton irradiation of human leukocytes is reported along with RBE values. Data given for all four cellular systems indicate that there is a response to increasing LET with a change in RBE; and the increase occurs within the same LET range, about 100 to 200 MeV cm^2/gm. M.W.R.

N65-34583* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
BIOLOGICAL EFFECTS OF PROTONS AND NEUTRONS IN LARGE ANIMALS
S. Tom Taketa *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 73–84 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Data obtained from midpoint tissue doses (MTD) administered to monkeys show that the effectiveness of high energy protons in large animals may be less than that of gamma rays, X-rays, or fast neutrons. There is insufficient experimental data, however, to consider a maximum permissible emergency exposure for space explorers. Results are presented for studies to determine biological effects of high energy protons as compared to Co^{60} gamma rays in whole body irradiated monkeys. Proton exposures ranged from 200 to 950 rads midpoint air dose (MAD), and gamma exposures were from 195 to 1065 rads. Dose rate was about 20 rads per minute for both proton and gamma irradiation. Depth-dose measurements indicate a dose falloff at midpoint in gamma exposures, but a dose buildup in proton exposures. Minimal lethal doses for gamma and proton irradiated monkeys were 485 and 500 rads with MAD, 325 and 650 rads for MTD, and 340 and 565 rads for average body dose. White blood corpuscle depression occurred at about the same point for gamma and proton irradiation, with figures between 190 and 290 rads. M.W.R.

N65-34584* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
THE RADIOBIOLOGICAL CONSEQUENCES OF DOSE DISTRIBUTIONS PRODUCED BY SOLAR-FLARE-TYPE SPECTRA
Robert K. Jones, Duane E. Adams, and Irving J. Russell (AF Weapons Lab.) *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 85–96 refs Prepared in cooperation with AF Weapons Lab. (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

None of the three high flux flares examined would have represented a serious radiation hazard to an astronaut in polar orbit, even if he would have experienced the full flux in a Gemini vehicle shielded only by the magnetosphere. Proton flux for the three events, represented a range of spectral types and each event was in excess of 30 MeV. It is concluded that there would be no danger even if the alpha particle component were to lead to a doubling of the surface dose. In addition to the partial shielding from the Gemini vehicle, the effect of the flare is ameliorated by the relatively low surface dose, steep depth dose profile, and protracted delivery of the dose. Additional protection can result from approximately 5 gm/cm^2 of shielding properly disposed about the astronaut; this would reduce dosage to eyes, chest, and gonads by a factor of three to 10 with the addition of only 20 pounds of weight. Difference in white blood count and platelet responses of sheep to neutron and X-ray radiations is charted. A comparison of the death distribution derived from the three higher doses of fission spectrum neutrons and X-rays reveals that neutron-exposed sheep die somewhat sooner than those exposed to X-rays. M.W.R.

N65-34585* California Univ., Berkeley. Lawrence Radiation Lab.
EFFECT OF HIGH-ENERGY PROTONS AND ALPHA PARTICLES ON SMALL MAMMALS
Charles A. Sondhaus *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 97–103 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

A review of experiments on rats and mice indicates a value of relative effectiveness about 0.7 to 0.8 times that of 250 kVp X-radiation for 50% mortality at 30 days for protons at several energies above 50 MeV. Whether the exposure is monodirectional or isotropic, both the build-up of secondary particle dose and the gross nonuniformity of total dose distribution are minimal in this energy range. The difference in relative predominance of gut and bone marrow injury has been found with alpha particle exposures as well as with protons. Both calculation and experiment suggest that a gamma photon flux at ordinary X-ray energies will produce a high secondary electron flux in small cavities, and this may result in a higher dose to bone marrow than to soft tissues. It is concluded that dose distribution, and probably dose rate factors are at least

as important as the ionization density or LET in assessing relative effects of high energy particles on mammalian systems. M.W.R.

N65-34586* California Univ., Berkeley. Donner Lab.
BIOLOGICAL EFFECTS OF HEAVY IONS
Paul Todd *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 105–114 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

Experiments with primary cosmic rays, neutron-induced reactions, and accelerated heavy ions are discussed in a paper dealing with the biological effects of heavy ions. The distinguishing characteristic of heavy ion radiation is its ability to kill large numbers of cells with very high probability; a single heavy ion can produce this lethal effect. Mutagenic and physiological effects seem less sensitive to large increases of the LET of ionizing radiations. A maximum mutation cross section in yeast, for example, appears at 100 $Å^2$, which is not much greater than a single nucleotide. Relative cell losses in a homogeneous biological system exposed to primary cosmic radiation are expected to be 1.1, and 0.7 for heavy, medium, and light nuclei, respectively, assuming that a heavy nucleus inactivates each cell it traverses. It is yet to be determined whether heavy nuclei inactivate all cells through which they pass or only those cells which are struck in the nucleus. M.W.R.

N65-34587* Battelle Memorial Inst., Columbus, Ohio.
A SUMMARY OF RADIATION EFFECTS THRESHOLDS
Donald J. Hamman *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 117–120 (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Relative radiation effect thresholds of four types of materials in a neutron environment indicate that structural metals are the most radiation resistant, followed by ceramics and electronic materials, and semiconductors are the most sensitive to radiation. A table of relative radiation resistance of polymers suggests that polyurethane rubber is one of the most resistant elastomers to radiation degradation; natural rubber has about the same resistance. Of the organic materials, the filled phenolic and epoxy resins are probably the most resistant, and tetrafluoroethylene is the most sensitive. Of the electronic materials and devices, the organic insulations and magnetic materials are the most resistant; other items, in order of decreasing radiation resistance, are piezoelectric crystals; resistors, capacitors, and electron tubes; transducers; organic insulation; and semiconductors. M.W.R.

N65-34591* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
STATUS REPORT ON THE SPACE RADIATION EFFECTS ON THE APOLLO MISSION. A: APOLLO DOSE LIMITS
John Billingham *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 139–141 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Radiation protection criteria specified for crew members in earth orbital and lunar Apollo missions are reviewed, and the various recommendations which led to the establishment of radiation dose limits are summarized. The radiation exposure dose limits are tabulated according to critical organ; maximum permissible integrated dose, rem; RBE, rem/rad; average yearly dose, rad; maximum permissible single acute emergency exposure, rad; and location of dose point. The maximum permissible single acute emergency exposure, rem, is also tabulated for each critical organ. Operational avoidance procedures are discussed, and it is estimated that the probability of no exposure to doses higher than the emergency limit is greater than 0.995; the probability of serious injury or death is lower than 1 even if the doses reach the limit. M.G.J.

N65-34592* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
STATUS REPORT ON THE SPACE RADIATION EFFECTS ON THE APOLLO MISSION. B: APOLLO SHIELDING ANALYSIS
Donald E. Robbins *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 143–145 ref (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

The calculations used, and the general results obtained from an analysis of space radiation doses inside the Apollo spacecraft are discussed. Two computer programs, used for predicting the dose from alphas and protons, are briefly described. In the spherical geometry program the spacecraft was broken into spherical solid angles with components homogenized for each solid angle, and only the primary dose was calculated, using the range energy relation for energy degradation. As the geometry description was unrealistic, the second program was written to describe the spacecraft components both chemically and geometrically, and to place them in a vehicle coordinate system. Preliminary results show that a spatial variation of a factor of two was found between points near the center of the spacecraft and the inside surface of the skin. Supporting data used in the studies are also mentioned. M.G.J.

N65-34593* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
STATUS REPORT ON THE SPACE RADIATION EFFECTS ON THE APOLLO MISSION. C: APOLLO RADIATION ENVIRONMENT ANALYSIS
Jerry L. Modisette *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 147–149 ref (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

An Apollo radiation environment analysis, based on a compilation of solar particle events over the last sunspot cycle, shows the Apollo radiation hazard to be less severe than originally estimated. The frequency of occurrence of solar proton events plotted against the sunspot number showed a correlation coefficient of 0.7. Although scatter made it impossible to determine the exact relationship between events and the sunspot number, it was concluded that a relationship exists between the sunspot number and the number of protons, and that there is a tendency for proton events to occur in groups. Procedural details are given for estimating the distribution of proton events for a hypothetical two-week mission. An approach to an operations environment analysis is also discussed, with dose distribution used rather than flux because of the variation in shielding and spectrum over different parts of the mission. Results indicate that there is less than 1 chance in 1000 that the emergency dose limits will be exceeded inside the command module on the first lunar mission. M.G.J.

N65-34594* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
STATUS REPORT ON THE SPACE RADIATION EFFECTS ON THE APOLLO MISSION. D: OPERATIONAL PROCEDURES FOR APOLLO DOSE RADIATION
Peter W. Higgins *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 151–156 (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Various methods for achieving dose reduction from solar proton radiation are discussed. Emphasis is placed on operational procedures which imply the use of mission modifications rather than an increase of shield thickness to achieve additional radiation protection. The procedures outlined include observations

to detect the approach of a solar proton event by a worldwide network of solar hydrogen-alpha and radio frequency telescopes; seven optical telescope units, and three radio telescope units are planned. The development of the Solar Particle Alert Network (SPAN) is also discussed. It is pointed out that, based upon this solar-proton-event information, dose reduction can be obtained by reducing the exposure time, with the time reduction determined in relation to the expected size and severity of the event. M.G.J.

N65-34596* Oak Ridge National Lab., Tenn.
CALCULATED TISSUE CURRENT-TO-DOSE CONVERSION FACTORS FOR NUCLEONS OF ENERGY BELOW 400 MeV
W. E. Kinney and C. D. Zerby (Union Carbide Res. Inst.) *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 161–172 refs Prepared in Cooperation with Union Carbide Res. Inst. (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

A series of Monte Carlo calculations were carried out to determine details about the energy deposition in tissue as a function of depth. From these data, rad and rem doses were calculated; and current-to-dose conversion factors for the surface and 5-cm depth doses, and for the average whole body and peak doses were extracted for hazard evaluation. Both incident neutrons and protons from 60 to 400 MeV incident energy were considered. The methods employed in the calculations are described, and the results compared with experiment and previous data. Results indicate that heavy particle recoils make a significant contribution to the rem dose for the case of incident neutrons or protons. In the case of incident protons, the contribution is on the order of 10 to 20 percent, but for incident neutrons it constitutes the greatest fraction of the total contribution. Based on these findings, it is assumed that the rem dose at any depth from incident protons can be calculated accurately unless the secondary radiation created in the body is taken into consideration. M.G.J.

N65-34597* Oak Ridge National Lab., Tenn.
THE SECONDARY-PARTICLE CONTRIBUTION TO THE DOSE FROM MONOENERGETIC PROTON BEAMS AND THE VALIDITY OF CURRENT-TO-DOSE CONVERSION FACTORS
D. C. Irving, R. G. Alsmiller, Jr., W. E. Kinney, and H. S. Moran *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 173–176 ref (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

The validity of the current-to-dose conversion factors was investigated for the case of monoenergetic protons isotropically incident on an infinite slab shield followed by a slab of tissue. Calculations were done by the Monte Carlo method using the nucleon transport code. Carbon, aluminum, and copper were considered as shield materials, and in all calculations a 30-cm thick slab of tissue followed the shield. Monoenergetic protons of energy (100 or 400 MeV) were taken to be incident on the shield with the angular distribution of a current due to an isotropic flux. Details on the calculations are given, and typical results are tabulated. Data show that the current-to-dose conversions generally provide a fair estimate of the actual dose, and in most cases the actual dose is bracketed by the two estimates; in no case did a current-to-dose conversion disagree with the actual dose by more than a factor of 2. The relative contribution of primary and secondary particles to the total dose was determined, and the error involved in a calculation which neglected secondary particles was estimated. M.G.J.

N65-34598* Oak Ridge National Lab., Tenn.
THE VALIDITY OF THE STRAIGHTAHEAD APPROXIMATION IN SPACE VEHICLE SHIELDING STUDIES
R. F. Alsmiller, Jr., D. C. Irving, W. E. Kinney, and H. S. Moran *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 177–181 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

To test the validity of the straightahead approximation, calculations were carried out and compared with results obtained with the angular distribution of the secondary particles taken into account. The straightahead approximation is applied to both elastic and nonelastic collisions, and all emergent particles are assumed to go in the forward direction. The nucleon transport code, with which the exact calculations were done, was used; the only change made in the code was in the angular distribution of the scattered particles. From the results of the comparative data, the straightahead approximation appears to be quite good. An alternative procedure is also discussed, in which the straightahead approximation current at the shield tissue interface is calculated, and the current-to-dose conversion factors are applied to this current. Results of the case considered showed that the normal conversion underestimates the primary proton and total dose, but overestimates the secondary proton and secondary neutron dose. It was pointed out that as Monte Carlo methods were used in the calculations, a standard deviation of about 10% is associated with each entry. M.G.J.

N65-34603* Boeing Co., Seattle, Wash.
FRACTIONAL CELL LETHALITY APPROACH TO SPACE RADIATION HAZARDS
S. B. Curtis, D. L. Dye, and W. R. Sheldon *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 219–223 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

A method of radiation hazard evaluation has been introduced in which the fractional number of cells of an organ killed or inactivated is calculated. This fractional cell lethality (FCL) depends only on the particle energy spectrum and the probability of cell inactivation. Recent data on inactivation cross sections of human kidney cells have been used to calculate the contribution of protons, alpha particles, and M-group particles to the FCL of the kidney. The results indicate that the proton and alpha particle contributions would have been the same order of magnitude for the 12 November 1960 giant flare and that their relative contribution does not vary much with shielding thickness. For a seated astronaut, the FCL values are on the order of 5 percent under reasonable shielding at points 4 and 6 cm inside the body at the waist. When data on inactivation cross sections become available on more critical organs, containing cells not replaced by the body, this approach may yield a realistic evaluation of the hazard from high LET radiation on extended space missions. Author

N65-34605* Republic Aviation Corp., Farmingdale, N. Y.
QUALITY FACTORS FOR DEGRADED PROTON SPECTRA
Richard Madey and Thomas E. Stephenson *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 229–234 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Analytical expressions were derived for the quality factors (QF) averaged over the proton dose absorbed in tissue at the center of a spherical shell shield bombarded by a spectral distribution of omnidirectionally incident protons. The relationship between linear energy transfer (LET) and QF is tabulated, and implies that the QF for X- and gamma-rays is close to

unity, and for electrons is greater than unity only at very low energies. A log-log plot shows the monoenergetic QF as a function of LET. Equations are given for calculating the QF at the center of a water sphere for omnidirectionally incident proton spectra as a function of the size of the sphere, expressed in terms of the kinetic energy of a proton that comes to rest after penetrating a distance equal to the radius of the sphere. The relative contributions to the mean QF from the high and low LET portions of a degraded spectrum at the center of a water sphere, bombarded by a solar proton flux with a spectral exponent $\gamma = 2.8$, are plotted as a function of the sphere radius measured in terms of the proton threshold penetration energy.
M.G.J.

N65-34607* Oak Ridge National Lab., Tenn.
AN APPLICATION OF THE GENERALIZED CONCEPT OF DOSIMETRY TO SPACE RADIATIONS
H. A. Wright, G. S. Hurst, and E. B. Wagner *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 245–250 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

The application of the generalized concept of dosimetry to the dosimetry of high energy protons is illustrated. Calculations have been made of the distribution of energy losses in an array of silicon detectors exposed to an isotropic flux of monoenergetic protons. The array consists of a main crystal of dimensions 1 × 1 × 1 cm bounded on each of its six faces by a crystal of dimensions 0.1 × 1 × 1 cm. A computer code has been used to plot the distribution of energy losses for several selected energies up to 400 MeV. An energy loss operator is defined which transforms an energy loss distribution function into a dose function. This operator can be used to calculate the rem dose accurately at selected energies and to within a given tolerance at intermediate energies. An electronic circuit is described which selects energy loss signals from the detector and routes them to the appropriate section of a data processor, thus permitting the calculation of the dose received from radiation by high energy protons of arbitrary energy spectrum.
Author

N65-34611* California Univ., Berkeley. Lawrence Radiation Lab.
PRIMARY AND SECONDARY-PROTON DOSE RATES IN SPHERES AND SLABS OF TISSUE
Roger Wallace, Palmer G. Steward, and Charles Sondhaus *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 301–329 refs (See N65-34575 22-29) GPO: $3.25 CFSTI: MF $2.50
(Contract W-7405-ENG-48)

A code has been developed for the depth dose relation in spheres of tissue due to primary protons and to cascade, evaporation, and hydrogen elastically scattered secondary protons. It is shown that the dose rate at a depth *d* in a slab due to a normally incident parallel broad beam of protons is the same as the dose rate at the center of a sphere of radius *d* when an isotropic flux is incident upon the sphere. The depth dose results are checked by experiments using 730 MeV protons, and compared with Monte Carlo calculations performed at Oak Ridge for 400 MeV protons. The results show that the depth dose pattern varies widely with proton energy and sphere size. For certain intermediate proton energies, the primary protons cause a peak dose rate at a predictable depth in the sphere. The secondary proton dose rate increases with increasing incident proton energy, sphere size, and depth. Protons of 730 MeV cause a secondary proton dose at the center of a 2.5-cm radius sphere which is 14% of the total dose, 35% for a 10-cm radius, and 48% for a #25-cm radius.
Author

N65-34629* United Nuclear Corp., White Plains, N. Y.
ANALYTICAL FORMULATION OF PROTON DOSE RATES BEHIND SPHERICAL MULTILAYER SHIELDS
F. R. Nakache *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 485–491 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(Contract NAS8-5277)

As a part of the studies on spherical minimum weight proton shields, analytical expressions were derived for calculating several types of primary proton dose rates, such as average body doses, skin doses, depth doses, and local doses. These expressions are believed to be more general and capable of wider application than those heretofore found in the literature. In addition, they eliminate the need of numerical integration. The only restrictions to their application are that the shield layers and the crew man model must be spherical, and the incident proton spectra must have an isotropic angular distribution.
Author

N65-34630* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE CALCULATION OF PROTON PENETRATION AND DOSE RATES
Martin O. Burrell *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 493–505 refs (See N65-34575 22-29) GPO: $3.25 CFSTI: MF $2.50

Calculational methods for the determination of the proton energy degradation and flux attenuation as a function of penetration depth in various materials are discussed and innovations to previous methods are presented. The main improvement proposed is the introduction of an approximation for the proton range which represents the theoretical data with an accuracy of ±4% or better for energies from around 5 MeV to 1200 MeV. The energy spectra of primary protons; multilayer shields; nonelastic proton collisions and secondaries; and proton dose rate expressions for the primary proton tissue dose or dose rate as a function of shield thickness or depth dose in tissue are considered. Analytical calculations are compared with those derived from numerical methods. Results obtained by the equations presented compare favorably with values obtained by others. Limitations of the method are also discussed.
E.E.B.

N65-34631* Naval School of Aviation Medicine, Pensacola, Fla.
LOCAL DOSE FROM PROTON AND ALPHA PARTICLE ENDERS BEHIND COMPLEX SHIELD SYSTEMS
Hermann J. Schaefer *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 507–512 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-75)

Flux ratios as high as 1 to 1 for protons/alpha particles in the integral rigidity spectra of some flare produced solar beams have been reported. Evaluation of tissue depth doses for the shield configuration of the Apollo vehicle shows that the alpha component contributes significantly to total exposure only for low shielding and only in the superficial layers of a tissue target. The fractional high LET dose due to alpha enders, however, is substantially larger than the corresponding dose from proton enders even at greater depths. Separate measurement of the high LET fraction of total dose and proper determination of RBE and QF factors, therefore, seems of even greater importance for the alpha component than for protons.
Author

N65-34632* North American Aviation, Inc., El Segundo, Calif.
RBE OF PROTONS AND ALPHA PARTICLES
J. W. Haffner *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 513–525 refs (See N65-34575 22-29) GPO: $3.25 CFSTI: MF $2.50

The RBE-LET (relative biological effectiveness-linear energy transfer) relationship of Rossi was used as a starting point for an analytical investigation into the RBE of protons and alpha particles. Charge acquisition was handled explicitly, nuclear interactions, implicitly, in this study, which yielded analytical expressions for the RBE of protons and alpha particles. The expressions simplify considerably above the critical energies where the RBE = 1. The critical energies are 10.8 MeV for protons and 249 MeV for alpha particles. Continuous energy spectra of the $E^{-\alpha}$ type were also treated. Comparisons with experimental data are presented. Author

N65-34633* North American Aviation, Inc., El Segundo, Calif.
AN EXAMINATION OF THE RELATIVE MERITS OF STOCHASTIC AND NONSTATISTICAL METHODS OF COMPUTING PRIMARY IONIZATION DOSES
B. Liley and G. C. Schaedle *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 527–533 (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

This paper will discuss several questions concerning computation of primary ionization doses for solar flare proton rigidity spectra with stochastic and nonstatistical methods. The following topics will be considered: (1) geometrical representations for dose computations; (2) the effect of spacecraft area density distribution function parameters on the degree of geometrical detail or precision which is desirable for dose computations with nonstatistical methods. Illustration of the effect of geometry detail on dose computed for an actual spacecraft; (3) convergence properties for the Monte Carlo method of dose computation as a function of rigidity and the geometry distribution parameters; the necessity of accounting for nuclear collisions when computing primary ionization doses; the effect of nuclear collisions on the convergence of the primary ionization dose; (4) dose computational accuracy of the statistical primary ionization dose; and (5) relative merits of nonstatistical and statistical methods of dose computation (tradeoffs between dose computational accuracy and cost). Author

N65-34634* Lockheed-Georgia, Marietta.
A SPACE RADIATION SHIELDING CODE FOR REALISTIC VEHICLE GEOMETRIES
K. M. Simpson, C. W. Hill, and C. C. Douglass *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 535–539 (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(Contract NAS8-11164)

This paper describes a computer code system which estimates primary proton and associated secondary dose at points within complex geometric configurations. Three computer programs constitute the system. The geometry program manipulates geometric data and computes penetration thicknesses. The geometry test program scans the input geometric data for character and format errors, checks for logical inconsistencies, and plots, off line, selected cross sections of the geometric representation in order that a visual inspection of the geometric configuration may be made. The dose program combines radiation source data and geometric data and computes the dose at specified detector points. Author

N65-34676# Joint Publications Research Service, Washington, D. C.
STATE OF THE VESTIBULAR ANALYZER IN PERSONS WORKING WITH SOURCES OF IONIZING RADIATION
A. A. Model 27 Sep. 1965 7 p refs Transl. into ENGLISH from Med. Radiol. (Moscow), v. 10, no. 5, May 1965 p 71–74
(JPRS-32151; TT-65-32644) CFSTI: $1.00

The functional state of the vestibular analyzer was investigated by means of caloric and rotation tests. It was indicated that the stimuli of the vestibular analyzer that differed in nature acted on the same receptor apparatus of that analyzer, and calorization was a weaker stimulus than rotation. Disturbances in functional state of the vestibular analyzer were observed in 44 subjects. In five subjects the experimental nystagmus lasted longer in response to the stimuli of varied intensity. In some cases the experimental nystagmus was shorter or its latent period grew longer; this was combined with a normal response to rotation. Therefore, calorization was insufficient to obtain a normal response, while rotation produced a normal response. A decline in the functional activity was observed in these cases. Cases of stronger vestibular responses to the calorization test than to the rotation test were also observed; this indicated a paradoxical response and was attributable to disturbances in the autonomic regulation of subcortical formations. R.W.H.

N65-34678# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
TOLERANCES OF THE HUMAN FACE TO CRASH IMPACT
John J. Swearingen Jul. 1965 26 p refs
(AM-65-20)

Evaluation of the injury potentials of commercial airline seat structures, light-aircraft instrument panels, and other deforming structures requires data on forces that produce fractures, lacerations, or unconsciousness when applied to different parts of the face. Unconscious commercial passengers, although not seriously burned, may asphyxiate or burn to death in a few minutes. Data of facial tolerances of living human heads and forces required to render unconsciousness were gathered by an intensive study of injuries in automobile accidents. These data were checked by making a series of 45 cadaver head impacts against deforming structures. Results show that blows of as low as 30 to 40 g for 10 to 40 milliseconds will produce temporary unconsciousness. Maximum forces that may be tolerated without fracture when the face is impacted against a surface that is designed to deform and conform to the contour of the facial bones are given. Author

N65-34680# Picatinny Arsenal, Dover, N. J.
THE HEALTH HAZARDS OF CERTAIN SMOKE DYES IN CURRENT USE
Alfred F. Tatyrek Sep. 1965 26 p refs
(PA-TM-1674; AD-469867)

A literature survey and discussions with qualified toxicologists has disclosed that: (1) Yellow dye, Indanthrene Golden Yellow, MIL-D-50029B, is toxic and may contain traces of 2, 4, 8, 9-dibenzpyrene, a very hazardous carcinogen (cancer-producing material). (2) Red dye, 1-methylaminoanthraquinone, MIL-D-3284A, is a skin sensitizer and is possibly a carcinogen. (3) Yellow dye, auramine hydrochloride, is hazardous because it is very toxic and is a potent carcinogen. (4) Small, repeated doses of a carcinogen are the most hazardous type of exposure an individual may be subjected to. The toxic and carcinogenic health hazards associated with the currently used smoke dyes, and also with possible candidates for smoke dyes, are discussed

with reference to effects of exposure, chemical structure, hazardous impurities, and pyrolysis reaction products. Recommendations for avoiding these health hazards are also presented. Author

N65-34703# Battelle-Northwest, Richland, Wash.
SWIN IN BIOMEDICAL RESEARCH Selected List of References, 1960–May 1965
J. C. Pekas and L. K. Bustad Jun. 1965 157 p refs
(Contract AT(45-1)-1830)
(BNWL-115)

05 BIOTECHNOLOGY

Includes life support systems, human engineering, crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N65-33554 Goodyear Aerospace Corp., Litchfield Park, Ariz.
VARIABLES INFLUENCING IMAGE INTERPRETATION PERFORMANCE IN MANNED SPACE SURVEILLANCE SYSTEMS
P. E. Resta *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 63–69 refs (See N65-33550 22-13)

Successful human performance of a surveillance mission in manned orbital space systems requires intensified research on the variables which influence the detection, identification and interpretation of targets on remote sensor displays. The human operator, display, target, and vehicular variables which relate to image interpretation performance in a space environment are reviewed and inadequacies of current data regarding interacting effects of variables are discussed. Author

N65-33631* Republic Aviation Corp., Farmingdale, N. Y.
CLOSED ATMOSPHERES
George A. Albright *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. D [1964] 64 p refs (See N65-33625 22-32) CFSTI: HC $6.00/MF $1.25

The current state-of-the-art of ground-based simulation to check out life support systems for contaminants, and to establish their biological significance is evaluated. Observed environmental stresses or factors, from launch to reentry and return to earth from orbit, consist of weightlessness, dynamic factors, ionizing radiation, cabin atmosphere, contaminants, thermal environment, circadian rhythms, and psychological factors. The complexity of future life support systems for longer space missions that must integrate food, water, and waste management, in addition to atmospheric and thermal control, is briefly outlined. G.G.

N65-33714*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
HOW TO SEE YOUR OWN FOVEA
J. Y. Lettvin and Samy Frenk [1964] 2 p Submitted for Publication
(Grants NsG-496; NSF GP-2495; NIH-G-MH-04737-04; Contracts DA-36-039-AMC-03200(E); AF 33(615)-1747)
(NASA-CR-58190) CFSTI: HC $1.00/MF $0.50 CSCL 06D

A procedure involving motion of a light directed at the closed human eye is described which makes it possible for the subject to view the cellular elements overlying the cones in his own retina. J.M.D.

N65-33767# George Washington Univ., Washington, D. C. Human Resources Research Office.
CONTROLLING THE QUALITY OF TRAINING
Robert G. Smith, Jr. Jun. 1965 48 p refs
(Contract DA-44-188-ARO-2)
(TR-65-6; AD-618737)

The need for a quality control system in a military training program and methods of establishing such a unit are described and evaluated in this report, which is part of a research project in the technology for developing training. It is stated that the purpose of quality control is to ensure a satisfactory standard of competence among the students who graduate, to maintain this quality by a continuous monitoring process, and to improve training where it is found to be deficient. In order to function successfully, a quality control system should constitute a separate unit, independent of but cooperating with the instructional departments. Attention is given to proficiency testing as the chief means of measuring the success of the training program, with emphasis upon the importance of a uniform standard and consistent method in the preparation, administration, and scoring of tests. Author

N65-33972*# American Inst. for Research, Pittsburgh, Pa.
THE ROLE OF HUMAN FACTORS TASK DATA IN AEROSPACE SYSTEM DESIGN AND DEVELOPMENT Technical Report, 15 Jun. 1964–15 Feb. 1965
L. Duncan Hannah, John A. Boldovici, James W. Altman, and Raymond C. Manion Wright-Patterson AFB, Ohio, AMRL, Aug. 1965 96 p refs
(Contracts NASr-194; AF 33(615)-1557)
(NASA-CR-67080; AMRL-TR-65-131) CFSTI: HC $3.00/MF $0.75 CSCL 05E

On the basis of information gathered from generators and users of human factors task data by both interviews and questionnaires and by a review of relevant literature, human factors personnel and data were identified, the relations between them described, and recommendations for an automated human factors task data handling system proposed. Human factors personnel were clearly divisible into four hierarchically arranged groups: Program Level Managers, Personnel Subsystem Managers, Department Heads, and Nonmanagerial Personnel. In general, and for the populations described, managers or supervisors were the principal users and nonmanagerial personnel the principal generators of human factors data. A framework that permits classification of both formatted and unformatted data was proposed as responsive to the generally felt need by data generators and users for more orderly "book-keeping" in the human factors realm. Desirable characteristics of an automated human factors task data handling system were derived from the questionnaire responses. Author

N65-33981# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
THE EQUIDISTANCE TENDENCY AND ITS CONSEQUENCES: PROBLEMS IN DEPTH PERCEPTION
Walter C. Gogel Apr. 1965 16 p refs
(AM-65-11)

The equidistance tendency is the tendency for objects or other inhomogeneities in the field-of-view to appear at the same distance as each other with the strength of this tendency being inversely related to directional separation. The evidence for the existence of the equidistance tendency and for its ability to modify the perceived depth resulting from size or stereoscopic cues is reviewed. The equidistance tendency is discussed as a disturbing factor in visual experimentation and as a necessary factor in the understanding of Emmert's law, the moon illusion, and similar phenomena. Several possible explanations for the equidistance tendency are evaluated in terms of the range of phenomena with which it is identified. Author

N65-34006* United Aircraft Corp., Windsor Locks, Conn. Hamilton Standard Div.
TELEMETRY SYSTEMS—REDUCTION TO PRACTICE
P. R. Amlinger and M. L. Hanson *In its* Med. and Biol. Appl. of Space Telemetry Jul. 1965 p 33–51 (See N65-34001 22-04)
GPO: $0.45; CFSTI: MF $0.75

Biotelemetry is being adopted because there are requirements for measuring more parameters with less patient interference. Equipment designers look to microminiaturization for reduced size, lower power, and increased reliability. This new method of designing circuits will lead to better devices. But with each improvement will come the demand for still better units. Author

N65-34020# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
PILOT FATIGUE: INTERNATIONAL JET FLIGHT. 1: OKLAHOMA CITY—TOKYO
George T. Hauty and Thomas Adams Mar. 1965 25 p refs
(AM-65-16)

Following 3 consecutive days of biomedical assessment in Oklahoma City, six healthy subjects were transported to Tokyo, where assessments were made on alternate days throughout a period of 10 days, and were then transported back to Oklahoma City, where assessments were made for 3 consecutive days. Based upon the single parameter of rectal temperatures, the mean values of all subjects revealed that biological time had apparently shifted from Oklahoma City to Tokyo time within 3 days and from Tokyo back to Oklahoma City time within 1 day. Individual rectal temperature curves of the different subjects, however, revealed a profound range of individual differences. The mean proficiency with which the subjects executed basic task functions was adversely affected to a substantial extent during the first day in Tokyo and, to a lesser extent, the first day of return to Oklahoma City. Author

N65-34133# California Univ., Los Angeles. Biotechnology Lab.
UPPER EXTREMITY PROSTHETICS RESEARCH, HUMAN TRACKING, SENSORY MOTOR CONTROL, MYOELECTRIC CONTROL Progress Report, Mar. 15–Jul. 15, 1965
15 Jul. 1965 20 p refs
(Contracts VA-V1005P-9779, N123(60530)32857A; AF-33(615)-1969; Grant VRA RD-1201M-64)
(Rept.-65-31; AD-619528)

Research activities are outlined for studies relating to upper extremity prosthetics, army prostheses sensory motor control problems, and analysis of prosthesis-amputee systems. Externally-powered prostheses and the utility of minor surgical alterations to body control sites for such devices are considered. Harnessing techniques for a mechano-electrical transducer to selected control sites and development of an external "logic" system with a minimum number of body control sites are discussed. Performance of human operators is considered in relation to tracking systems and to multi-dimensional myoelectric control systems. M.W.R.

N65-34266# School of Aerospace Medicine, Brooks AFB, Tex.
EEG ELECTRODES FOR IN-FLIGHT MONITORING
Eric R. Skov and David G. Simons Apr. 1965 10 p refs
(SAM-TR-65-18; AD-468524)

An electrode is described for in-flight recording of EEG. The electrode provides significant improvement over previously available types. When properly applied, it produces little noise, even when tapped. It is resistant to accidental dislodgement and is comfortable under close-fitting headgear. The leads, a major problem source, may easily be replaced. The impedance between two electrodes is 5,000 ohms or less, permitting use with miniature transistorized amplifiers. Author

N65-34279# General Electric Co., Philadelphia, Pa. Missile and Space Div.
RESEARCH STUDY OF THE BIOMEDICAL ASPECTS OF AEROSPACE SYSTEMS ENVIRONMENTAL CHAMBER MARK I. PHASE V: STUDY OF MAN RATING, SUBSYSTEM DESIGN CRITERIA Technical Report, Jan.–Mar. 1964
R. A. Miller, S. W. Meyer, and R. Mader Arnold AF Station, Tenn., Arnold Eng. Develop. Center, Aug. 1965
(Contract AF 40(600)-1012)
(AEDC-TR-65-179, Vol. II; AD-469039)

This report presents design criteria that were evolved for certain specialized subsystems that are necessary to man rate the AEDC Mark I Aerospace Systems Environmental Chamber. Criteria were developed for the following subsystems: (1) Remote Environmental Control Systems (ECS) to sustain full pressure suited men, (2) ECS—to suit umbilicals (Preliminary), (3) ECS/Biomedical Control Console, (4) Rapid Repressurization Subsystem (Preliminary) and (5) Biomedical Facilities Special Requirements. The depth and detail of the criteria evolved during this phase of the Mark I Man Rating were limited by available funding and tight schedule requirements. Author

N65-34302# Autonetics, Downey, Calif.
A COMPARISON OF OPERABILITY AND READABILITY OF FOUR TYPES OF ROTARY SELECTOR SWITCHES
Peter E. Kolesnik Jun. 1965 23 p refs
(T5-1187/3111; AD-617914)

The object of this study was to compare operator performance with four types of rotary selector switches. They included a conventional fixed-scale, moving-pointer switch and three types of fixed-pointer, moving-scale designs—one exposing a single digit, one exposing three digits, and one continually exposing 10 digits. Specific parameters investigated were speed and accuracy of control positioning, and accuracy of reading under four limited exposure times. In addition, each subject ranked the four types of controls according to the degree of difficulty he encountered in using them. Results indicated that positioning performance with the fixed-scale, moving-pointer switch was significantly faster than with the three types of fixed-pointer, moving-scale switches. No practical differences were obtained among the switches for positioning errors. Nevertheless, individuals indicated subjective preference for the fixed-scale over the three types of moving-scale switches. It was concluded that moving-scale switches are superior to fixed-scale switches, where accuracy of reading is more important than speed of setting. Author

N65-34383# Electro-Voice, Inc., Buchanan, Mich. Engineering Dept.
[RESEARCH ON A HELMET, A HARDSHELL EARPHONE SYSTEM, AND A MICROPHONE] Status Report No. 6, Aug. 15–Sep. 15, 1964
Robert C. Ramsey [1964] 6 p
(Contract AF 33(615)-1295)
(AD-460990)

Continued research focusing on the design and fabrication of a noise attenuating helmet for use by astronauts during blastoff is reported. Subjective tests indicated that the acoustic characteristics of the helmet were peaked in the bass range. Proposed is the use of a hardshell earphone for achieving additional attenuation, providing adequate attenuation of bass frequencies, and reducing inherent problems induced by intense

vibration during blastoff. Studies focusing on the development of a light weight earcup for use in the hardshell were initiated. Sandwich type hardshells of an aluminum honeycomb- and foam-material were constructed, and a preliminary model constructed for testing the attenuation. Only the hardshells formed using rigid urethane foam appeared to have sufficient rigidity to be useful. S.C.W.

N65-34419# Innsbruck Univ. (Austria).
COLOR DISCRIMINATION WITHOUT CHROMATIC VISION Final Technical Report, Jul. 1, 1964–Jul. 31, 1965
A. Hajos and E. Hajos 1 Jul. 1965 39 p refs
(Contract DA-91-591-EUC-3325)
(FTR-1; AD-469260)

Adaptation of chromatic aberrations artificially produced by wearing prismatic glasses, and compensation for the normal chromatic aberrations of the eye were investigated. Experiments were conducted in which the subjects wore prism spectacles, with one eye covered. It was shown that the adaptations of the subjects to the distortions of prism spectacles—the apparent spatial dislocation of objects, the apparent curvature of straight lines, fictitious movements, etc.—were transferred from the viewing eye to the covered eye when the eye cover was interchanged. The experiments with colorblind (protanope) subjects showed that they could use the chromatic distortions caused by prism spectacles for color separation. Investigations were also performed in regard to the problems of the intermanual transfer of adaptation under variations of the absolute depth localization. Based on these findings it was shown that within a short time, a correction to the absolute depth localization develops. This correction was disturbed by the squinting caused by the prisms. R.W.H.

N65-34500*# National Aeronautics and Space Administration, Washington, D. C.
RANGE ESTIMATION OF FAMILIAR TARGETS PRESENTED AGAINST A BLACK BACKGROUND
Gary P. Beasley and Jack E. Pennington Washington, NASA, Oct. 1965 25 p
(NASA-TN-D-2845) CFSTI: HC $1.00/MF $0.50 CSCL 05H

A series of tests has been conducted to determine the human ability to judge range with no cues except the apparent size of the object viewed. This visual situation could occur in many space operations. Subjects were asked to estimate the distance to targets of known size placed at random distances and uniformly illuminated. The targets were a plane triangle, a disk, and three proportional cylinders. The tests were conducted in a 2800-foot-long darkened building. Results show that subjects tended to overestimate the range of the smaller models and to underestimate the range of the larger models. Subjects were able to estimate accurately the range of receding targets at much greater ranges than that of approaching targets. It appears possible to apply the pilot's visual acuity (the ability to distinguish fine detail) to make estimates accurate over a greater range. The point at which the size and shape of a particular target can first be resolved could determine a specific range on which subsequent estimates could be based. This possibility was not investigated in this test series, but such a technique, based on test results, is suggested. Author

N65-34518# Systems Technology, Inc., Hawthorne, Calif.
HUMAN PILOT DYNAMICS IN COMPENSATORY SYSTEMS. THEORY, MODELS, AND EXPERIMENTS WITH CONTROLLED ELEMENT AND FORCING FUNCTION VARIATIONS
Duane Mc Ruer, Dunstan Graham, Ezra Krendel, and William Reisener, Jr. (Franklin Inst.) Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Jul. 1965 213 p refs Prepared jointly with Franklin Inst.
(Contract AF 33(616)-7501)
(AFFDL-TR-65-15; AD-470337)

The description of human pilot dynamic characteristics in mathematical terms compatible with flight control engineering practice is an essential prerequisite to the analytical treatment of manual vehicular control systems. The enormously adaptive nature of the human pilot makes such a description exceedingly difficult to obtain, although a quasi-linear model with parameters which vary with the system task variables has been successfully applied to many flight situations. The primary purposes of the experimental series reported are the validation of an existing quasi-linear pilot model, and the extension of this model in accuracy and detail. Author

N65-34537# Human Factors Research, Inc., Los Angeles, Calif.
GEOGRAPHIC ORIENTATION IN AIRCRAFT PILOTS: CHART SCALE AND PILOT PERFORMANCE
James J. Mc Grath, William E. Osterhoff, and Gail J. Borden Jul. 1965 37 p refs
(Contract Nonr-421800)
(TR-751-4; AD-619780)

An experiment was conducted to test the hypothesis that the Sectional Aeronautical Chart could be reduced in scale without detrimental effect on geographic orientation performance. Using a cinema method to simulate the visual aspects of low-altitude navigation, pilot orientation performances were measured under different chart conditions. Under one condition the pilots used a standard 1:500 000 scale Sectional and under the other condition they used the same chart reduced to a 1:1 000 000 scale. The results did not support the hypotheses, but showed that chart scale had a significant effect on orientation performance. However, the direction of the effect depended upon the particular route flown. Orientation performance was better with the reduced scale on one route, but better with the standard scale on another route. A theoretical explanation of the complex results was offered, based on orientation strategies adopted by the pilots under different conditions of flight. The implications of the orientation-strategy model for the design of aeronautical charts and navigation displays were discussed. Author

N65-34545# Air Force Systems Command, Wright-Patterson AFB, Ohio. Behavioral Sciences Lab.
A PRELIMINARY STUDY OF THE EFFECTS OF BRIEFING LEVELS ON RECONNAISSANCE PERFORMANCE WITH SIDE-LOOKING RADAR Technical Report; Jan.–Mar. 1964
J. C. Welch and Don F. Mc Kechnie Oct. 1964 25 p ref
(AMRL-TR-64-101; AD-608887)

Sixteen Air Force navigators were tested, after appropriate training, on four strips of side-looking radar imagery. The imagery, at a scale of 1: 197 000, moved across a back-lighted 14- by 14-inch screen at 3.3 inches per minute—corresponding to 500 knots. The subject's task was to identify all airfields, bridges, tank farms, power lines and railroad yards. The speed and accuracy of locating and identifying these targets under four different levels of briefing were assessed. The four briefing levels were: none, 10 minutes study of the corresponding chart prior to the simulated flight, access to the chart during but not prior to the flight, 10 minutes study of the chart prior to the flight and access to it during the flight. Fifty-six percent of the targets were correctly identified. On the average the target traveled 3.1 inches (56 seconds) after first appearing on the screen before being identified. False positive responses

averaged 30%. The briefing levels compared, however, had no significant differential effects on the speed and accuracy of identifying targets or on the number of false positives. This should not be interpreted to mean that briefings will not be required for side-looking radar. It does suggest that new briefing techniques and materials will need to be developed.
Author

N65-34557# Tufts Univ., Medford, Mass.
THE MEASUREMENT OF CONFIDENCE AND TRUST Interim Report, Nov. 1964–Apr. 1965
Thornton B. Roby and Teresa Carterette (Simmons Coll.) Bedford, Mass., AFSC, Electron. Systems Div., Apr. 1965 35 p refs
(Contracts AF 19(628)-2450; Nonr-494(15))
(ESD-TDR-65-299; AD-619953)

This report is concerned with the development of a research methodology and a theoretical framework for investigating the effects of social influence in a simple judgmental situation. The laboratory task entails a simple binary judgment as to whether a displayed angle departs from 90° ; before making his own response the subject is provided with the answer of a hypothetical partner, programed at a certain fixed accuracy level. The responses are made in terms of a special betting scheme which penalizes the subject for overstating or understating his confidence. The two main experimental variables in this study are the difficulty of the discrimination and the announced reliability of the hypothetical partner. Theoretical predictions as to the effects of these variables on the relative value of confidence measures are confirmed. However, further methodological development is required to increase the realism of subjects' confidence scores.
Author

N65-34570# Philco Corp., Blue Bell, Pa. Advanced Communications Lab.
VOICE SOUND RECOGNITION Final Report, Apr. 1964–Apr. 1965
Charles F. Teacher and Casimir F. Piotrowski Griffiss AFB, N. Y., RADC, Jul. 1965 124 p refs
(Contract AF 30(602)-3384)
(RADC-TR-65-184; AD-619964)

This report examines the merits of a new speech perception theory and its application to the voice sound recognition problem. Most conventional speech recognition systems require 7 important parameters to activate the recognition logic: the frequency of the first three formants, the amplitude of the first three formants and a voice-unvoiced decision. The theory tested uses just three important parameters: the frequency of a "single equivalent formant" (SEF), the SEF amplitude, and a voicing decision. This decrease of more than two to one in input parameters should mean significantly more than a two to one reduction in the complexity of the recognition logic. Statistics were compiled on a set of 20 words uttered by an ensemble of 5 speakers (3 male and 2 female). Although some recognition confusions were encountered in some phonetically similar sounds they were not unexpected, since the statistics were compiled on segmented phonemes (sans transient cues). However, other confusions were the result of imperfect parameter extractors, and hopefully will be corrected as improved circuits are developed. Recognition rates as high as 98 percent were measured in this initial phase of the program. Author

N65-34571# Rome Air Development Center, Griffiss AFB, N. Y.
SPEED OF IDENTIFICATION OF TELEVISED SYMBOLS AS A FUNCTION OF VERTICAL RESOLUTION Final Report
Merrill F. Elias Jul. 1965 23 p refs
(RADC-TR-65-239; AD-619958)

An experiment was performed to determine the effect of vertical symbol resolution on speed of identification of televised letters and numbers. Subjects viewed 36 alphanumeric symbols, 10 times under 7 conditions of symbol resolution (5 to 11 scan lines), and under a solid-symbol (nontelevised) control condition. Performance showed a progressive improvement from 5 to 11 lines, but did not reach a level obtained with solid symbols. It was concluded that 11 lines approaches an optimal level of resolution, and that reduction in symbol resolution much below 11 lines should be approached with caution.
Author

N65-34620* North American Aviation, Inc., El Segundo, Calif.
THE IMPORTANCE OF SPACE RADIATION SHIELDING WEIGHT
E. R. Beever and D. H. Rusling *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 407–414 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

The shielding weights required to protect astronauts against space radiation should be considered in relation to the weights of the meteoroid shielding and the life support systems. Comparisons have been carried out for a variety of crew sizes and mission durations. The radiation shield weights were based upon a 1% probability and were obtained from Webber's data on solar proton events. A mission dose of 100 rad was used as the allowed limit. The doses allowed from solar events were reduced by 45 mrad/day due to galactic radiation and by the amount of radiation expected for two high thrust trips through the earth's trapped radiation belts. In the calculation of the shield weights, the "storm cellar" concept was employed, allotting 50 ft^3 per man. The single shield thicknesses calculated were modified to take into account the reduced penetration where two facing sheets with space between them are used as the meteoroid shield. A 1% probability of penetration was assumed in calculations.
Author

N65-34683# Naval Ordnance Test Station, China Lake, Calif.
VISUAL SEARCH EXPERIMENTS: ACUITY, RESPONSE TIME, NOISE PERSISTENCE
Ronald A. Erickson Jul. 1965 51 p refs
(NAVWEPS-8731; NOTS-TP-3787; AD-619507)

This experiment demonstrated the degradation in search performance resulting from a decrease in the frame rate of a static, structured display containing television-type visual "noise". The display was produced by projecting moving pictures of the static, structured scene; the noise in the scene was obtained by the double exposure and special printing of the film. Results indicate that restricted usefulness of a low frame rate, television-type display may be expected in a low signal-to-noise ratio condition. Neither peripheral and foveal acuity nor eye dominance scores correlated significantly with search time. There was a significant correlation between response time and search time; this is attributed to the mental image processing and decision time common to both tasks.
Author

N65-34684# George Washington Univ., Washington, D. C. Human Resources Research Office.
THE EFFECT OF TRAINING ON ACCURACY OF ANGLE ESTIMATION
T. Gary Waller and Robert H. Wright Aug. 1965 32 p refs
(Contract DA-44-188-ARO-2)
(TR-65-8; AD-619958)

This study examined the feasibility of using direct perceptual estimation on maps to determine angles of drift, and the effect of training on this ability. Subjects were divided

into a control group and two training groups, one of which was trained using angles drawn on plain white cards, and the other using angles drawn on both cards and tactical maps. Both training groups initially estimated the size of angles, ranging from 1° to 18°, with a mean absolute error of 2.57° and a mean algebraic error of −0.20°. After training, absolute error was 1.34° and algebraic error was +0.43°. A job aid consisting of reference angles of 5°, 10°, and 15° did not significantly affect performance on map items, although on card items, performance of the training groups shifted from underestimation to slight overestimation of angle size. Author

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N65-33685# Thiokol Chemical Corp., Trenton, N. J. Chemical Operations.
NITROSO RUBBER RESEARCH, DEVELOPMENT AND PRODUCTION, 1 MARCH–31 MAY 1964
Joseph Green [1964] 24 p refs Prepared in Part at Thiokol Chem. Corp., Denville, N.J.
(Contract DA-19-129-AMC-69(X))
(RD-343-Q5; RMD-8576-Q5; AD-460938)

The preparative processes developed for CF_3CO_2NO, CF_3NO, and the CF_3NO/C_2F_4 copolymer have been operated successfully. Single production runs yielded 15 lb of CF_3NO and 13.5 lb of copolymer (mol. wt. about 1,500,000). Copolymer development and termonomer studies were continued. The heat of the CF_3NO/C_2F_4 copolymerization has been determined experimentally. The value is 74.8 ±0.5 kcal/mole. Author

N65-33691# Army Chemical Center, Edgewood, Md. Nuclear Defense Lab.
THE RESPONSE OF THE SYSTEM TRICHLOROETHYLENE-OXYGEN-WATER TO DIFFERENT GAMMA DOSE RATES Technical Report, Nov. 1964–Apr. 1965
Ronald Sassé Jul. 1965 25 p
(NDL-TR-67; AD-469129)

A study was undertaken to measure the net effect of varying the delivery rate of gamma radiation. Experiments were designed to measure the $G(H^+)$ produced in oxygen-saturated and oxygen-free TCE solutions at rates to 1.65×10^6 rad/h. These experiments employed the lowest dose that could be accurately given to a solution in the high-dose irradiation. The oxygen-saturated aqueous trichloroethylene system showed a 65-percent loss of response when absorbing 1.65×10^6 rad/h. The air-free trichloroethylene system did not show any such large rate-dependent effect. The difference between the high and low flux values reported in this work is 8 percent; however, this difference, if real, is small. Author

N65-33724*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE POLYCRYSTALLINE EPR SPECTRUM OF FE^{+3} IONS IN MAGNESIUM OXIDE
Jack H. Lunsford 19 May 1964 6 p refs Submitted for Publication
(NASA-TM-X-51862) CFSTI: HC $1.00/MF $0.50 CSCL 07D

Theoretical and experimental calculations were performed to determine whether the anisotropic line near g = 2.00 in the paramagnetic resonance spectrum of reagent grade magnesium oxide is the powder spectrum from Fe^{+3} ions in a cubic field. In addition, comparisons were made between the cubic-field-splitting parameters in powders and in larger single crystals. A theoretical polycrystalline spectrum was calculated, and the line shape for a single orientation was approximated. The calculated curve for the variation in the anisotropic line width was in good agreement with the experimental curve. It was concluded that the anisotropic spectrum observed is from Fe^{+3} ions in a cubic field. G.A.L.

N65-33750*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE FORMATION OF THE KAMACITE PHASE IN METALLIC METEORITES
J. I. Goldstein Jun. 1965 28 p refs
(NASA-TM-X-55268; X-641-65-205) CFSTI: HC $2.00/MF $0.50 CSCL 08G

In order to predict the concentration gradients in meteoritic kamacite, the newly determined Fe-Ni phase diagram of Goldstein and Ogilvie was applied and a diffusion analysis was developed. The results of the diffusion analysis show that the kamacite phase cannot remain in equilibrium at low cooling temperatures and a Ni depletion in the kamacite near the α/γ interface occurs below 450° C. In addition certain other features of the kamacite phase are predicted: (1) an increasing Ni concentration from the center of the kamacite phase towards the α/γ interface in coarse and medium octahedrites, (2) a variation in the average Ni content of the average sized kamacite bands with the overall Ni content of the meteorite, and (3) the average composition of kamacite plates of the same width is the same no matter what the overall Ni content of the parent meteorite is. These predictions have been confirmed by electron probe measurements of several metallic meteorites. This correlation is in agreement with cooling rates of parent bodies which form at low pressures. Author

N65-33754# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SHIPBOARD AND COASTLINE OXYGEN PLANTS
G. K. Geynrikhs 12 Jul. 1965 411 p refs Transl. into ENGLISH of the book "Sudovyye i Beregovyye Kislorodnyye Ustanovki" Leningrad, Gos. Soyuzn. Izd. Sudostr. Prom., 1965 p 1–341
(FTD-TT-65-288/1+2; AD-618871)

General information is given about the technology of obtaining oxygen from atmospheric air by the deep-freezing method; marine oxygen installations, special features of installing compressors aboard ships; expansion engine installation; pipeline installation; installing deep-freeze units and air purification devices; oxygen cisterns; and tanks. Also discussed are servicing and installation; operation of compressor machinery; expansion engine operation; air purification apparatus and servicing; engineering process of obtaining oxygen by the deep-freezing method; floating oxygen cisterns; methods for decreasing liquid oxygen losses during storage and transportation; servicing marine oxygen cisterns; gasification of liquid oxygen; and controlling the main indicators of an oxygen installation's operation. TAB

N65-33771# Naval Research Lab., Washington, D. C. Surface Chemistry Branch.
SURFACE CHEMICAL METHODS OF DISPLACING WATER AND/OR OILS AND SALVAGING FLOODED EQUIPMENT. PART 4: AGGRESSIVE CLEANER FORMULATIONS FOR USE ON CORRODED EQUIPMENT

H. R. Baker and P. B. Leach 15 Jun. 1965 17 p refs
(NRL-6291; AD-618956) CFSTI: $1.00

The surface chemical techniques previously reported from this Laboratory for the removal of oily contamination, sea water, and fresh water from electronic and electrical equipment after flooding are not designed to remove the corrosion products which often form on some parts of equipment after salt water exposure. Thickened "paint-on" spot-cleaning compositions have been developed for the removal of such corrosion from aluminum, copper, brass, steel, cadmium plate, and zinc plate. The formulations employ solid chemicals to the maximum extent possible, the solids being combined with water or commercially available mineral acids just before use. The use of such aggressive cleaners may advantageously precede the surface chemical treatment described previously. Author

N65-33777# Argonne National Lab., Ill.
EQUILIBRIUM IN THE SYSTEM NH_4F-BeF_2-H_2O AT 0° [RAVNOVESIE V SISTEME NH_4F-BeF_2-H_2O PRI 0°]
A. V. Novoselova and M. Ya Averkova Oct. 1964 6 p refs Transl. into ENGLISH from Zh. Obshch. Khim. (Moscow), v. 9, no. 12, 1939 p 1063–1066
(ANL-TRANS-116)

The ternary system NH_4F-BeF_2-H_2O at 0° C was studied. The system's solubility curve consisted of four branches and the salt $NH_4F \times BeF_2$ separated out from the solution when the ratio of the amounts of NH_4F and BeF_2 expressed in moles was equal to 1. The solubility of this salt at 0° C is equal to 46.9 g in 100 g of the solution. $NH_4F \times BeF_2$ was also obtained synthetically from the reaction of beryllium hydroxide with hydrofluoric acid and ammonium carbonate. This reaction proceeds according to the equation:

$$2Be(OH)_2 + 6HF + (NH_4)_2CO_3 = CO_2 + 2NH_4BeF_3 + 5H_2O.$$

G.G.

N65-33787# Argonne National Lab., Ill.
THE STATE OF SODIUM DISSOLVED IN NaOH-MELTS [UBER DEN ZUSTRAND DES IN NaOH-SCHMELZEN GELOSTEN NATRIUMS]
F. Halla and H. Tompa May 1965 9 p refs Transl. into ENGLISH from Z. Anorg. Allgem. Chem. 219 (Leipzig), Iss. 4, 1934 p 321–331
(ANL-TRANS-186)

The dissolution of metallic sodium in molten sodium hydroxide proceeds with the formation of Na_2O and NaH according to the equation: $2\,Na + NaOH = Na_2O + NaH$. The melting point of pure NaOH was determined as 327.6 ±0.9° C. A formula was presented for the dependence of this melting point on the water and carbonate content. The effects of the bottom phases upon the shape of the phase diagram were discussed. R.W.H.

N65-33788# Los Alamos Scientific Lab., N. Mex.
DETERMINATION OF TRACE AMOUNTS OF OXYGEN ADDED TO METALLIC SODIUM
K. S. Bergstrasser, G. R. Waterbury, and C. F. Metz 24 Aug. 1965 35 p refs
(Contract W-7405-ENG-36)
(LA-3343) CFSTI: $2.00

Development and evaluation of a method for determining 1 to 10 ppm of oxygen in sodium metal is described in this progress report. A system was designed for maintaining a supply of low-oxygen sodium and for quantitatively separating, by vacuum distillation, metallic sodium from oxygen-containing impurities in portions of this metal. The nonvolatile residue was dissolved in dilute hydrochloric acid and analyzed with a flame spectrophotometer for sodium as an indirect measurement of the oxygen concentration, assuming that the distillation residue was sodium monoxide. To determine the reliability of the method, samples prepared by adding controlled quantities of oxygen, as water, to sodium metal were analyzed by the described method. The recovery of the added oxygen was quantitative, and the standard deviation of a single measurement was 0.5 ppm in the oxygen concentration range of 1 to 10 ppm. The method requires a minimum of transfer operations and has potential applications, and limitations, in connection with sodium reactor technology. Author

N65-33826*# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.
INVESTIGATION OF BATTERY ACTIVE NICKEL OXIDES Final Report
P. Ritterman and H. N. Seiger 11 Jun. 1965 94 p refs
(Contract NAS3-4178)
(NASA-CR-54654) CFSTI: HC $3.00/MF $0.75 CSCL 07D

A study of the compounds formed on a nickel oxide electrode with respect to charged stand, charge rate, state-of-charge, and during overcharge has been made. This was done by means of X-ray diffraction, differential thermal analysis, chemical analysis and spectrography. The majority of the work was done by means of X-ray diffraction. It has been found that the active compounds of the electrode are essentially β NiOOH and $Ni(OH)_2$ during ordinary conditions of charge and discharge. During overcharge, an unstable compound is formed having the X-ray patterns resembling those of γ NiOOH. These patterns were obtained by means of X-ray monitoring a two plate cell during overcharge. Data of the decay of this compound on open circuit are also presented. Differential thermal analysis has indicated the existence of a compound of nickel at the "graphitic" level which differs from both β NiOOH and $Ni(OH)_2$. Initial cycling data and testing are also presented for sintered plate nickel and tubular graphite types of positive plates. Author

N65-33860*# North Carolina State Coll., Raleigh. Dept. of Engineering Research.
CONDENSATE REMOVAL BY CENTRIFUGAL FORCE Final Report, 1 Mar. 1960–28 Feb. 1963
K. O. Beatty, Jr. [1963] 29 p refs
(Grant NsG-59-60)
(NASA-CR-64909) CFSTI: HC $2.00/MF $0.50 CSCL 07A

Measurements of heat transfer coefficients during condensation of vapors on the upper surface of a flat, water-cooled disk rotating at velocities of 140 to 5000 rpm, are reported. Runs were made with pure vapors of methanol, ethanol, refrigerant-113, water, and also with methanol vapors containing varying percentages of nitrogen or carbon dioxide as non-condensable diluents. As rotational speeds were increased, heat transfer coefficients increased somewhat more slowly than predicted by theory and appeared to reach maximum value in the region near 4000 to 5000 rpm. Speeds above 3000 rpm produced little enhancement of the obtained coefficients. Rotational speeds for the runs with non-condensables present were limited to a maximum of 1000 rpm since increased rotational velocities had only a small effect on their heat transfer coefficients. G.G.

N65-33873*# AVCO Corp., Wilmington, Mass. Research and Advanced Development Div.
EVALUATION OF HIGH-TEMPERATURE GAS TRANSPORT PROPERTIES First Quarterly Progress Report, 29 Apr.–28 Jul. 1965

16 Aug. 1965 38 p refs
(Contract NASw-1188)
(NASA-CR-67012; RAD-SR-65-190) CFSTI: HC $2.00/MF $0.50 CSCL 07D

Arc column temperature distributions and voltage gradients have been determined in nitrogen for various arc currents at pressures of 0.5, 1, and 2 atmospheres. These data have been analyzed to determine thermal conductivity as a function of temperature by integrating the Elenbaas-Heller equation. The thermal conductivities were found to have an anomalous dependence upon the ambient pressure of the arc column and upon the arc current. It is postulated that these effects may be attributed to radiative losses, particularly in the far ultraviolet. Significantly better agreement is obtained between the experimental and theoretical thermal conductivities when these radiative losses are included in the energy balance.
Author

N65-33917# MSA Research Corp., Callery, Pa.
THERMOPHYSICAL AND TRANSPORT PROPERTIES OF LIQUID METALS Quarterly Progress Report No. 3, Jul.–Sep. 1964
F. Tepper, J. Zelenak, F. Roehlich, and V. May 19 Oct. 1964 39 p refs
(Contract AF 33(615)-1273)
(MSAR-64-116; AD-460879)

Liquid sodium density measurements were determined experimentally from 411° to 2030° F; two separate charges of sodium metal were used in obtaining the data. In the statistical analysis, three regression lines were obtained by the least squares method, and the equations and their standard deviations are presented in tabular form. Equations for determining the electrical resistivity and thermal conductivity of liquid lithium from the melting point to 2000° F are also given. The apparatus and procedure used for obtaining the surface tension of cesium from the melting point to ~1850° F are described, and the data obtained at various temperatures are plotted. In calculating liquid rubidium viscosity, a computer program was written to reduce the period and decrement measurements made on the rubidium-containing oscillating cylinder to viscosity values. Comparisons of experimental viscosity values with calculated values are shown. The vapor pressure of NaK-78 was also determined from 1000° to 2000° F, and results are presented graphically for the experimental work on cesium PVT. Also included are tabular data on the vapor viscosity of argon.
M.G.J.

N65-33926# Atomic Energy Commission, Washington, D. C. Div. of Technical Information.
THERMAL DECOMPOSITION OF ALUMINUM NITRATE
Max Buchner [1965] 6 p refs Transl. into ENGLISH from German Patent No. 556,140, 8 Jan. 1926
(AEC-TR-6557)

A method for the thermal decomposition of aluminum nitrate is given. The process is carried out in such a manner that aluminum nitrate or aluminum nitrate solution is heated to temperatures up to 500° C. During the heating indifferent gases (nitrogen, carbon dioxide, air) are passed over it. The formation of nitrous gases is considerably suppressed, and the gases which distill over represent nitric acid to a considerable degree. This nitric acid needs only to be condensed to be made useful again. An improvement to this process is shown to be possible by operating under reduced gas pressure. The elimination of impurities (particularly iron) from the aluminum nitrate is briefly discussed.
C.T.C.

N65-33941# Osterreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf (Austria). Institut für Chemie.
MOLECULAR PLATING. IV: A RAPID METHOD FOR THE ELECTRODEPOSITION OF PLUTONIUM
N. Getoff, H. Bildstein, H. Riedl, and H. Saukel 1965 12 p refs
(SGAE-CH-15/1965) CFSTI: HC $1.00/MF $0.50

A method for rapid electrodeposition and preparation of extremely uniform films of plutonium is described using isopropyl alcohol as solvent. In the presence of traces of alkali metal hydroxide it is possible to deposit plutonium quantitatively at 600 V in a short time. The plutonium films obtained are very suitable for activity measurements by gas flow counting and α-spectroscopy.
Author

N65-33944# Instituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
THE DISSOCIATION KINETICS AND THE STRUCTURE OF ERIPHIA HAEMOCYANIN [SULLA CINETICA DI DISSOCIAZIONE E SULLA STRUTTURA DELL'EMOCIANINA DI ERIPHIA]
L. Di Giamberardino and C. De Haën 10 Feb. 1965 46 p refs In ITALIAN; ENGLISH summary
(ISS-65/5) CFSTI: HC $2.00/MF $0.50

The pH dependent dissociation kinetics of Eriphia haemocyanin has been investigated with light scattering and ultracentrifuge methods. The dissociation curve is similar to the titration curve of ionizable groups. The native molecule has an $S_{20,w}$ equal to about 24 S; this dissociates in two 16 S subunits which further dissociate in a not defined number of 5 S subunits. The molecular weight of the three components are approximately 9×10^5, 4.5×10^5 and 0.9×10^5. It has been possible to separate the three components with sucrose-gradient centrifugation method. Electron microscopy suggests for 16 S subunit a cylindrical structure.
Author

N65-33947# Royal Aircraft Establishment, Farnborough (England).
ON THE AUTO-OXIDATION OF n-HEPTANE AND ISOMERIC n-HEPTANE-HYDROPEROXIDES [UBER DIE AUTOXYDATION VON n-HEPTANE UND DIE ISOMEREN n-HEPTANE-HYDROPEROXYDE]
W. Pritzkow and K. A. Muller Mar. 1965 25 p refs Transl. into ENGLISH from Ann. Chem. (Leipzig), v. 597, 1955 p 167–181
(RAE-LIB-TRANS-1104) CFSTI: HC $2.00/MF $0.50

All the isomeric n-heptane-hydroperoxides were prepared in the pure state, compared with those obtained by autooxidation of n-heptane, and catalytically decomposed in contact with salts of the heavy metals. From accurate investigations of the ketones which were obtained, it appears that the oxygen attack on n-heptane takes place statistically. A statistical attack was also proved in the case of the autooxidation of n-decane and n-dodecane.
Author

N65-33975*# Pennsylvania Univ., Philadelphia. Electrochemistry Lab.
STUDIES IN FUNDAMENTAL CHEMISTRY OF FUEL CELL REACTIONS Three-Quarter Progress Report, 1 Oct. 1964–30 Jun. 1965
John O'M. Bockris [1965] 228 p refs
(Grant NsG-325)
(NASA-CR-67000) CFSTI: HC $6.00/MF $1.50 CSCL 07D

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REACTIONS 10 p refs

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7. POTENTIAL OF ZERO CHARGE S. D. Argade and E. Gileadi 46 p refs (See N65-33976 22-06)

8. THE POTENTIAL SWEEP METHOD: A THEORETICAL ANALYSIS S. Srinivasan and E. Gileadi 32 p refs (See N65-33977 22-06)

9. PROTON TRANSFER ACROSS DOUBLE LAYERS: MECHANISM EVALUATION FROM ISOTOPE EFFECTS J. O'M. Bockris, S. Srinivasan, and D. B. Matthews 32 p refs (See N65-33978 22-06)

10. A BRIEF OUTLINE OF ELECTROCATALYSIS J. O'M. Bockris and S. Srinivasan 32 p refs (See N65-33979 22-06)

N65-33976* Pennsylvania Univ., Philadelphia. Electrochemistry Lab.

POTENTIAL OF ZERO CHARGE

Shyam D. Argade and E. Gileadi *In its* Studies in Fundamental Chem. of Fuel Cell Reactions [1965] 46 p refs (See N65-33975 22-06) CFSTI: HC $6.00/MF $1.50

Methods for determining the potential of zero charge, PZC, values for metals immersed in an electrolytic solution are described, and the PZC values of eighteen metals are tabulated. Surface tension methods such as the use of electrocapillary curves, and contact angles are described. Other methods described are the change of surface area, capacity measurements, adsorption, friction, angle of inclination, electrophoretic mobility, repulsion of double layers on two wires, and an ultrasonic method. Aspects of PZC in relation to a system are discussed, and equations relating to the charge are presented along with calculations. Data on reversible potentials of metals in the rational scale and their exchange current densities are listed; and tables of data are also given for the physiochemical characteristics of metals and a constant in the PZC equation. The data are graphically presented, and a schematic diagram of apparatus used in the determinations is shown. L.S.

N65-33977* Pennsylvania Univ., Philadelphia. Electrochemistry Lab.

THE POTENTIAL SWEEP METHOD: A THEORETICAL ANALYSIS

S. Srinivasan and E. Gileadi *In its* Studies in Fundamental Chem. of Fuel Cell Reactions [1965] 32 p refs (See N65-33975 22-06) CFSTI: HC $6.00/MF $1.50

A comparison is made of the current-time curve obtained by the potential sweep method and of the potential-time curve obtained galvanostatically. Limitations of the slow and of the fast potential sweep technique, from the point of view of obtaining kinetic data or coverages in the case of complex reactions (e.g., electroorganic oxidations) are discussed. A detailed mathematical analysis of the method is carried out for a charge transfer reaction of the type $A^- \rightarrow A + e_0$. Three cases which depend on the displacement of the reaction from equilibrium are distinguished. Analytic expressions are derived for the current as a function of potential, peak current and for the peak potential for the cases of quasi-equilibrium and condition under which the reverse reaction may be neglected. The experimental results of Will and Knorr on the adsorption of hydrogen and oxygen on Pt using the potential sweep method serve to verify the present theory. Author

N65-33978* Pennsylvania Univ., Philadelphia. Electrochemistry Lab

PROTON TRANSFER ACROSS DOUBLE LAYERS: MECHANISM EVALUATION FROM ISOTOPIC EFFECTS

J. O'M. Bockris, S. Srinivasan, and D. B. Matthews *In its* Studies in Fundamental Chem. of Fuel Cell Reactions [1965] 32 p refs (See N65-33975 22-06) CFSTI: HC $6.00/MF $1.50

Hydrogen-tritium (H-T) separation factors are used in determining the mechanism of the proton transfer process across double layers. Theoretical separation factors for different mechanisms are calculated, and the factors both including and excluding tunneling corrections are tabulated. They indicate that most mechanisms can be distinguished by means of separation factors except a linked discharge-electrochemical desorption mechanism where the rate determining step cannot be determined. The amount of hydrogen coverage on the metal is also required to make the distinction. The mechanism on metals studied in acid and alkaline electrolytes, obtained by using the separation factor method, are also tabulated. In addition the use of separation factors in ascertaining the degree of proton tunneling in the slow discharge mechanism, and the relation of the kinetics of hydrogen evolution to double layer structure are discussed. A classical evaluation of separation factors is reviewed with calculations pertaining to translational, rotational, and vibrational partition function ratios. L.S.

N65-33979* Pennsylvania Univ., Philadelphia. Electrochemistry Lab.

A BRIEF OUTLINE OF ELECTROCATALYSIS

J. O'M. Bockris and S. Srinivasan *In its* Studies in Fundamental Chem. of Fuel Cell Reactions [1965] 32 p refs (See N65-33975 22-06) CFSTI: HC $6.00/MF $1.50

Electrocatalysis is defined, and an empirical proof of its existence is presented. A simple example illustrating the influence of electrocatalysis on electrochemical energy conversion is given, and the extent to which electrocatalysis may be effected is discussed considering both basic principles and practical realizations. The influence of electronic and geometric factors, and the activation of an electrode process by radiation is discussed; and the use of a redox system to change the reaction path is considered. Limitations to a study of electrocatalysis are outlined. L.S.

N65-33980# Massachusetts Inst. of Tech., Cambridge. Lab. for Insulation Research.

THE DIELECTRIC SPECTRA OF WATER-ETHANOL MIXTURES IN THE MICROWAVE REGION

Douglas E. Buck Jun. 1965 19 p refs

(Contracts Nonr-1841 (10); AF 33(616)-8353)

(TR-200; AD-618409)

The dielectric constant and loss have been measured at 8.5, 3.0, 1.0, and 0.3 kMc/sec for solutions of ethanol and water as a function of concentration and temperature. The mixtures exhibit a distribution of relaxation times as opposed to single time constants for the pure components. The distribution of time constants has been resolved as the superposition of two dispersions, each having a single time constant. The intensity and time constant of the two dispersions have been found as a function of temperature and concentration and explained in terms of a mechanism in which hydrogen bonds are broken and allowed to reorient. In addition, the dielectric constant and loss were measured for water from 5° to −5° C, and no abnormal behavior was noted at 4° C or in the supercooled state. Author

N65-33984# New York Univ., N. Y. Research Div.
DEVELOPMENT OF COATINGS ADHERENT TO METALS UNDER VIBRATION CONDITIONS Intermediate Progress Report, 27 Apr. 1964–27 Apr. 1965
Max Kronstein 29 May 1965 83 p refs
(Contract NObs-90357)
(AD-618290)

The coating adherence to metals under vibration conditions is being studied as a system anchored to the metal in the interface area on the metal surface and on the interreaction between the primer coatings and the interface area. The stability of the subsequent coating applications is studied as influenced by the degree of curing or solvent release in the various coating layers. The influence of crosslinking agents on the result of the curing of polymer components is studied using primarily a vinyl cyclohexene dioxide and a reactive derivative of this same di-epoxide with tetra iso-propyl titanate as an effective crosslinking agent. Electron microscope studies are applied in this investigation. The vibration studies are made using a source of ultrasonic vibration in a 5% saltwater tank as a test medium. Author

N65-33990# Naval Ordnance Lab., White Oak, Md.
A METHOD FOR THE QUANTITATIVE ANALYSIS OF THE SILVER OXIDE CATHODE
Regina D. Wagner Aug. 1965 19 p
(NOLTR-64-214; AD-618479)

A method has been developed to quantitatively analyze mixtures of the silver oxides and silver metal such as occur in the silver oxide cathode of primary and secondary alkaline silver-zinc batteries. The detailed procedure is given and data verifying its accuracy presented. The occurrence of a reaction between argentic oxide and silver metal is also verified. Author

N65-33998# Atlantic Research Corp., Alexandria, Va.
ORGANOMETALLIC RADIATION DOSIMETRY SYSTEMS Research Report, May 1, 1962–Dec. 31, 1964
Joseph Kivel Washington, AEC, 31 May 1965 54 p refs
(Contract AT(30-1)-2979)
(NYO-2979-34) CFSTI: $3.00

Certain classes of metal-organic compounds were found to be applicable as gamma radiation dosimetry systems for total doses greater than one megarad. Systems investigated included: metal-acetylacetone chelates, organometallic compounds, and metal cupferrates. The acetylacetonates of chromium (III) and cobalt (III) in toluene were determined to be the most promising dosimetry systems. The yield of aqueous-extractable cobalt (III), by the radiolytic rupture of the metal-to-organic bond of the cobalt (III) acetylacetonate, was determined to be linear with radiation dose over the 0.5–20 megarad range. Irradiations were carried out using 80, 420 and 5,000 curie cobalt-60 sources. An 0.8% increase in yield per degree centigrade temperature rise was observed for the Co(III) chelate. Oxygen was shown to slightly decrease the yield of liberated metal and lead to greater scatter in the analytical results. Analysis by dilute nitric acid extraction of the metallic ion from the toluene solution, EDTA complexation and spectrophotometric determination yielded ±2% reproducibility for the cobalt (III) complex. Procedures for the use of these systems as chemical dosimeters are presented. Author

N65-34009*# Stauffer Chemical Co., Weston, Mich. Anderson Chemical Div.
RESEARCH AND DEVELOPMENT OF HIGH TEMPERATURE RESISTANT POLYMERIC FILM FORMING MATERIAL Final Summary Report, 1 Mar. 1961–17 Apr. 1962
I. M. Thomas, F. C. Davis, and R. S. Towers 15 May 1962 169 p refs
(Contract NAS8-1532)
(NASA-CR-64977) CFSTI: HC $4.00/MF $1.00 CSCL 07C

Reactions between bis-dialkylamino titanium, zirconium, aluminum, vanadium, and tantalum derivatives and diphenylsilanediol were used to obtain linear polymers containing an alternating -M-O-Si-O- backbone structure. Polymers of titanium and aluminum containing trialkylsilaxy ligands on the metal atoms were found to rearrange at low temperatures to give the monomeric $M(OSiR_3)_4$ derivatives and a crosslinked residue. Those polymers containing triphenylsiloxy ligands were also found to degrade at comparatively low temperatures. Polymers of titanium containing quinolin-8-oxy ligands did not rearrange; steric differences arose with the vanadium and tantalum elements and quinolin-8-oxy ligands. The covalency expansion of zirconium and aluminum was not satisfied by the quinolin-8-oxy ligand and rearrangements at low temperatures took place. The infrared spectra, physical properties, and thermal stabilities of model compounds and polymers were measured and are tabulated. G.G.

N65-34085# Naval Research Lab., Washington, D. C. Chemistry Div.
PHOTODEGRADATION OF HIGH POLYMERS. PART VI: PHOTOLYSIS OF POLYSTYRENE FILMS IN VACUUM AND IN AIR
R. B. Fox, L. G. Isaacs, F. E. Saalfeld, and M. V. Mc Dowell 16 Jun. 1965 21 p refs
(NRL-6284; AD-617952) CFSTI: $1.00

Thin films of polystyrene have been photolyzed by 2537A radiation in vacuum and in air at 25°, 80°, and 120° C. Random scission and crosslinking occur simultaneously, with oxygen acting to inhibit the latter process. During photolysis, hydrogen appears to be the major volatile product emanating from the polymer itself. Of the remaining volatile products, carbon monoxide, carbon dioxide, and methane probably arise from polymer imperfections; benzene and monomer are present as impurities rather than major photolysis products. Changes in the ultraviolet spectra during photolysis are compatible with the formation of conjugated double bonds along the main chain; in air, these changes are supplemented by oxidation which results in carbonyl formation along the chain and a relatively small fragment absorbing at about 340 mμ. Author

N65-34096 Naval Ordnance Lab., Corona, Calif.
INFRARED ATOMIC SPECTRA. DETERMINATION OF 5g LEVELS OF THE FIRST SPECTRA OF CHLORINE AND BROMINE
C. J. Humphreys and E. Paul, Jr. *In its* Foundational Res. Proj. 1 Jun. 1965 p 13–20 refs (See N65-34093 22-34)

It is reported that the observation and interpretation of atomic emission spectra in the 4-micron region was extended to include chlorine I, bromine I, and iodine I. The observing technique appears to be applicable in the instance of any gaseous or relatively volatile element. It involves microwave excitation of the spectrum in an electrodeless tube, and detection by use of a liquid-nitrogen-cooled PbS detector, which provides optimum response for the 4-micron region, although the response falls sharply beyond this point. Any of the halogens may be introduced into the source tube as the pure element, but a more energetic discharge was obtained by introducing a halide salt as the source material. Tables are included for the explicit diagonal energy expressions for ng, the $(^3P_2)4f\text{–}(^3P_2)5g$ transitions in chlorine I, the $(^3P_1)4f\text{–}(^3P_1)5g$ and $(^3P_0)4f\text{–}(^3P_0)5g$ transitions in chlorine I, the $(^3P_2)4f\text{–}(^3P_2)5g$ transitions of bromine I, and the Slater parameters associated with the 5g levels of chlorine I and bromine I. C.T.C.

N65-34100 Naval Ordnance Lab., Corona, Calif. Infrared Div.

SOLID STATE SPECTROSCOPY. ENERGY LEVELS OF Pr^{3+} IN LaF_3

H. H. Caspers, H. E. Rast, and R. A. Buchanan *In its* Foundational Res. Proj. 1 Jun. 1965 p 59–78 refs (See N65-34093 22-34)

Absorption and fluorescence spectra of Pr^{3+} in LaF_3 in the spectral region of 4000 to 6000 Å are presented. From these data and from previous published results, all the $2J + 1$ crystalline Stark levels for the terms of the f^2 configuration are determined, with the exceptions of the $^1S_0$ and the group of energy levels around 21 500 cm^{-1} C.T.C.

N65-34112# United Kingdom Atomic Energy Authority, Amersham (England). Natural Radioelements Dept.

A NEW METHOD FOR LEAK-TESTING SEALED SOURCES OF RADIUM-266 AND THORIUM-228

D. J. Dwight May 1965 7 p
(RCC-R-176)

A clarification of the quantitative interpretation of results obtained from the leak-testing of sealed sources of radium-226 and thorium-228 is presented. These results show the radon present at the end of a given period in a sealed enclosure containing a leaking source; the active deposit accumulated in the vicinity of the source as a result of a leak; and the total quantity of radon that leaked into the sealed enclosure during a given period. In the case of radon-222 detection, the effective number of particles in the decay chain is three. With a counter dead-time long compared with the 0.3 μ second half-life of Po-212, the disintegration of the Po-212 will not be resolved from that of its parent Bi-212. The number of counts per radon-220 disintegration will be 2.3. The mean detection is 0.96. R.W.H.

N65-34114# American Cyanamid Co., Stamford, Conn. Central Research Div.

CHEMILUMINESCENT MATERIALS Technical Report, 1 Mar.–31 May 1965

Michael M. Rauhut, L. J. Bollyky, R. A. Clarke, B. G. Roberts, A. M. Semsel et al [1965] 82 p refs
(Contract Nonr-4200(00); ARPA Order 299)
(TR-8; AD-466061)

Progress in determining mechanisms of processes fundamental to chemiluminescence is reported with particular reference to the chemiluminescent systems: (1) oxalyl chloride-hydrogen peroxide-fluorescer; (2) acyl-oxalic anhydride-hydrogen peroxide-fluorescer; (3) 9-chlorocarbonylacridinium salt-hydrogen peroxide; and (4) tetracyanoethylene-hydrogen peroxide-fluorescer. Exploratory searches for new chemiluminescent materials are also reported. Author

N65-34123# Airtron, Inc., Morris Plains, N. J.

ON THE PREPARATION OF SINGLE CRYSTAL FERRITE MATERIALS BY THE FLOATING ZONE TECHNIQUE Final Progress Report

Donald A. Lepore and Richard C. Puttbach 27 Jan. 1964 56 p refs
(Contract NOrd-18020)
(R11-441; AD-600062) CFSTI: $1.50

The growth of single crystal ferrites, by the floating zone technique, was extensively investigated. A pressure vessel, incorporating a floating zone mechanism was constructed; also, appropriate facilities were provided for high frequency induction heating. Investigations into the growth of single crystal ferrite by induction heating were carried out using floating zone, differential pulling, pulling from a self-contained melt, and stable-melt pulling methods. Also, several experiments were conducted to test the feasibility of radiation melting. The principal materials studied using the methods mentioned above were nickelferrite, magnetite, manganese ferrite, magnesium ferrite, nickel aluminum ferrite, and yttrium iron garnet. Experiments were conducted to determine suitable induction coils, and the effects of oxygen pressures on molten ferrites are considered. Possible causes for low resistivity and broad linewidth data are discussed. Author

N65-34132# Lithium Corp. of America, Inc., Bessemer City, N. C.

APPLICATION OF LITHIUM CHEMICALS FOR AIR REGENERATION OF MANNED SPACECRAFT

R. O. Bach, W. W. Boardman, Jr., and J. W. Robinson, Jr. Wright-Patterson AFB, Ohio, AMRL, Jun. 1965 131 p refs
(Contract AF 33(615)-1588)
(LCA-564; AMRL-TR-65-108; AD-619497)

Lithium oxide of highly active surface area ($10 m^2/g$ or better) has been prepared. This material can absorb up to 1.25 times its weight of carbon dioxide, thus making the most efficient CO_2 absorber on the basis of its weight. For efficient operation, the molar ratio of water vapor over carbon dioxide in the gaseous atmosphere should be at least unity. At 5 psia of oxygen and 50% relative humidity, the temperature of the gas should be at least 50° F (10° C) to approach this molar ratio value. A "passive-dynamic" atmosphere regeneration unit was designed with a small motor blower that circulates the gaseous environment through a cone shaped granular bed of lithium oxide (4-14 mesh). The unit weights 4-1/2 pounds and has been shown to absorb the daily carbon dioxide output, or more, of one man. The outflowing gas is free of irritating dust due to efficient filters and the gas temperatures are at comfortable levels. The effects of weightlessness, vibration and acceleration on the functioning of the unit, have been considered in its design. An adequate amount of safety of operation also was imparted to the unit. The unit can easily be recharged with fresh lithium oxide granules. Author

N65-34136# General Telephone and Electronics Labs., Inc., Bayside, N. Y.

EXPERIMENTAL STUDY OF FACTORS CONTROLLING THE EFFECTIVENESS OF HIGH-TEMPERATURE PROTECTIVE COATINGS FOR TUNGSTEN Technical Report, May 15, 1962–Aug. 31, 1964

J. Brett, L. L. Seigle, J. Berkowitz-Mattuck (Little (Arthur D.), Inc.), B. Lement (ManLabs, Inc.), D. I. Phalen (Battelle Memorial Inst.) et al Wright-Patterson AFB, Ohio, AF Mater. Lab., Aug. 1965 294 p refs
(Contract AF 33(657)-8787)
(TR-64-484.14; AFML-TR-64-392; AD-619867)

The restrictions imposed by the processes of diffusion, evaporation, and coating substrate reactions on the choice of potential protective coating materials for tungsten have been studied analytically and experimentally. The diffusive restriction is the most limiting and eliminates many refractory oxides with otherwise satisfactory attributes. The diffusive properties of rare earth sesquioxides and complex refractory oxides were explored by means of oxidation experiments and a layer growth experiment respectively. Mass spectrometric studies of the vaporization of refractory complex oxides were carried out to determine the applicability of the Wagner-Hauffe method of predicting vaporization rates. Provided certain thermodynamic approximations are valid and the vapor species over the complex oxide are the same as those over the pure component oxides, the predictions yield order of magnitude accuracy. A survey and exploration of reactions of possible coating materials with tungsten was

performed emphasizing promising materials from the diffusion studies. Author

N65-34196# Los Alamos Scientific Lab., N. Mex.
THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. VI: RHENIUM
D. F. Bowersox and J. A. Leary 3 Sep. 1965 11 p refs
(Contract W-7405-ENG-36)
(LA-3359) CFSTI: $1.00

The solubility of Re in liquid Pu has been studied over the range 700° to 950° C from 0 to 4 percent Re. The apparent solubility is given by the equation

$$\log N_{Re} = 0.1945 - 1.960 \times 10^{3} T^{-1}$$

where N_{Re} is the solubility of Re expressed as the mole fraction, and T is the temperature in degrees Kelvin. The solubility increased from 1.23 percent Re (by weight) at 700° C to 3.19 percent Re at 950° C. Author

N65-34199# Battelle-Northwest, Richland, Wash.
PARAMETRIC EVALUATION OF DTPA, EDTA, AND HEDTA FOR ION EXCHANGE PURIFICATION OF PROMETHIUM
E. J. Wheelwright and T. R. Myers Sep. 1965 19 p refs
(Contract AT(45-1)-1830)
(BNWL-69) CFSTI: $1.00

Optimum conditions for the purification of individual light rare earth elements by ion exchange elution were determined for the eluting agents diethylenetriaminepentaacetic acid (DPTA), ethylenediaminetetra-acetic acid (EDTA), and hydroxyethyl-ethylenediaminetri-acetic acid (HEDTA). The conditions apply directly to the production of macro amounts of pure promethium. DTPA was shown to be superior to both EDTA and HEDTA with feed solutions which do not contain significant amounts of Pb^{+2} or Y^{+3}. If Pb^{+2} or Y^{+3} are present, EDTA or a sequence of first DTPA and then EDTA gives better results than DTPA alone. Because of the much higher separation coefficient of promethium from cerium in the DTPA system and its use of a H^{+} retaining ion, an initial fast rough separation can be made with DTPA to reduce radiolysis from Ce^{144} and permits a reduction in column size for subsequent columns. The column equipment is described, and a flowsheet is proposed for a separation plant capable of producing high purity promethium. L.S.

N65-34202# Atomic Energy Commission, New York. Health and Safety Lab.
NUCLEAR EMULSION SPECTROMETRY AT LOW AND INTERMEDIATE NEUTRON ENERGIES
R. Sanna, K. O'Brien, M. Alberg, S. Rothenberg, and J. Mc Laughlin Washington, AEC, Jul. 1964 100 p refs
(HASL-162) CFSTI: $4.00

The use of nuclear emulsions to measure the neutron energy distribution is described. The relationship between the recoil proton spectrum and the neutron spectrum is an integral Fredholm equation; homogeneous, and of the first kind. The kernel of this equation is the differential energy cross section for the reaction H^{1} (n,p). The relationship of this cross section to the more usual differential angular cross-section in the center-of-mass is shown, and the formulas of Gammel used for computation are given. The integral equation was replaced with an explicit summation which permitted rewriting it as a matrix product. The neutron spectrum was iteratively solved using Scofield's method. The problem was ill-conditioned, and a method of finding an explicitly smooth solution was derived. R.W.H.

N65-34211# Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.
HIGH-TEMPERATURE STRUCTURAL RESINS Final Summary Report, 16 Apr. 1964–31 May 1965
Paul M. Hergenrother, Jerry L. Kerkmeyer, and Harold H. Levine May 1965 50 p refs
(Contract NOw-64-0524-c)
(AD-466574)

Polyimides, polybenzothiazoles, and polyquinoxalines continue to display excellent hydrolytic, oxidative and thermal stability. For example, the polymer decomposition temperatures of poly(*m*-phenylene)-3,3',4,4'-benzophenone-tetracarboxylimide, poly-2,2'-(*m*-phenylene)-6,6'-bibenzothiazole, and poly-2,2'-(*p,p'*-oxydiphenylene)-6,6'-biquinoxaline were 540° C, 570° C, and 520° C in air and 535° C, 640° C, and 500° C in helium respectively. The polyimides and polybenzothiazoles exhibited outstanding stability under isothermal conditions in air at 371° C (700° F). Unformulated polyquinoxaline bonds gave average tensile shear strengths of 4110 psi (no postcure) and 2780 psi (postcured) at room temperature, and 1760 psi (postcured) after 10 minutes at 800° F (tested at 800° F). Unformulated polybenzothiazole bonds gave average tensile shear strengths of 2550 psi at room temperature. A new route to polybenzothiazoles gave high molecular weight soluble precursor polymers which were readily converted to final polymers having outstanding thermal stability. Author

N65-34212# Argonne National Lab., Ill.
THE CHEMICAL ANALYSIS OF Pu, Pu ALLOYS, AND Pu COMPOUNDS: METHODS, TECHNIQUES, SEPARATIONS PROCEDURES, AND PHYSICAL DATA Annotated Bibliography, 1947–Mar. 1964
H. B. Evans and J. O. Karttunen Oct. 1964 113 p refs
(Contract W-31-109-ENG-38)
(ANL-6956) CFSTI: $4.00

An annotated bibliography which focuses primarily on analytical methodology used in the analysis of plutonium, plutonium alloys, and plutonium compounds; is reported. The scope of reported data exceeds strictly analytical procedures to provide a basis for further development of procedures for analyzing new compounds and alloys of plutonium, and new approaches to long standing problems. Literature covered includes physical chemistry, separations chemistry, physiological and criticality hazards, health and safety, glove-box construction and operation, and corrosion control. S.C.W.

N65-34280# AiResearch Mfg. Co., Los Angeles, Calif.
COLLECTIVE PROTECTION AGAINST CB AGENTS Fifth Bimonthly Progress Report, 1 Mar.–30 Apr. 1965
O. Makowski, G. Counas, and P. Stone Edgwood Arsenal, Md., Chem. Res. and Develop Labs., Jul. 1965 725 p refs
(Contract DA-18-035-AMC-279(A))
(CB-1005, Vol. 1; AD-468827)

Rate of approach to equilibrium for adsorbent at low coverage, heat of adsorption, and hysteresis loops were investigated in connection with studies on collective protection against CB agents. It was shown that a breakthrough equation can be developed in terms of the adsorption capacity of the charcoal, the rate constant per unit volume of bed for adsorption on clean charcoal, and the kinetic law by which adsorption decreases with amount adsorbed. Details are presented for 42 investigations under the general headings of *Air Purification, Entry Airlocks, New Concepts,* and *Feasibility Studies*. Tasks deals with subjects such as carbon sorbents, personnel and equipment decontamination, protective materials and procedures, and decomposition of toxic agents. A preliminary study of the removal of toxic material by liquid scrubbers was performed, and a shelter simulation model was developed. M.W.R

N65-34286# Peninsular ChemResearch, Inc., Gainesville, Fla. Research Div.

SYNTHESIS AND POLYMERIZATION OF FLUORINATED SULFUR MODIFIED NITROSO RUBBER Quarterly Report, 1 Oct.–31 Dec. 1964

Eugene C. Stump, Ward H. Oliver, and Calvin D. Dadgett 25 Jan. 1965 31 p

(Contract DA-19-129-AMC-152(N))

(QR-6; AD-463775)

Oxidation of 1,4-diaminobenzene with performic acid gives a compound tentatively identified as p-aminotetrafluoronitrosobenzene. Tetrafluoroterephthaloyl mononitrite could not be pyrolyzed to the nitroso derivative at 200° under vacuum. Additional quantities of CF_3NO (339 g.) were prepared. Perfluoropropylene epoxide was prepared by a reported procedure, but attempted epoxidation of perfluorobutadiene gave very little volatile product. Reaction of $CF_2 = CFLi$ and $CF_2 = CFMgBr$ with $(CH_3O)_2C=O$ did not give $CF_2 = CFCOOCH_3$. Properties of the new oxazine, $CF_3NOCF_2CF = CFCF_2$, are reported. Reaction of CF_3OF with $CF_3NO/CF_2 = CFCF = CF_2$ copolymer resulted in almost complete addition to the double bonds. A brief discussion of NMR analysis of nitroso polymers is presented. Perfluorobutadiene and 1,1,2-trifluorobutadiene polymerize in the nitroso system primarily by a 1,4 mechanism, although some 1,2 polymerization does occur to give pendent vinyl groups. Perfluoropropylene epoxide and ethylene oxide do not polymerize with CF_3NO under the conditions used. Author

N65-34317# Oak Ridge National Lab., Tenn.

OXIDE CHEMISTRY AND THERMODYNAMICS OF MOLTEN LITHIUM FLUORIDE–BERYLLIUM FLUORIDE BY EQUILIBRATION WITH GASEOUS WATER–HYDROGEN FLUORIDE MIXTURES

A. L. Mathews and C. F. Baes, Jr. (Ph.D. Thesis—Miss. Univ.) 7 May 1965 99 p refs

(ORNL-TR-1129)

The transpiration method was used to equilibrate dilute gaseous mixtures of HF and H_2O in H_2 gas with molten LiF–BeF_2 mixtures varying in composition from 0.25 to 0.80 BeF_2, both saturated and unsaturated with crystalline BeO, in the temperature range 500 to 700° C. The partial pressure data were used to evaluate the equilibrium quotient for the reaction of HF and H_2O with solid BeO and dissolved BeF_2. Equilibrium quotients were also obtained for the formation of oxide and hydroxide ions in the liquid phase. These equilibrium quotients were employed to determine: (1) thermodyamic activities of LiF and BeF_2 in the mixtures; (2) thermodynamics of liquid BeF_2; (3) stability of hydroxide in the melt; and (4) solubility of BeO in the LiF–BeF_2 system as a function of temperature. Author

N65-34318# Missouri School of Mines and Metallurgy, Rolla. Dept. of Chemical Engineering and Chemistry.

SEPARATION OF CESIUM AND STRONTIUM BY ELECTRODIALYSIS

H. C. Hershey, R. D. Mitchell, and W. H. Webb [1962] 9 p refs

(Contract AT(11-1)-770)

(COO-770-11)

The recovery of strontium and cesium from waste solutions of radioactive fission products was investigated by electrodialytic separation of the two species after they formed stable complexes with ethylenediaminetetraacetic acid (EDTA) or diethylenetriaminepentaacetic acid (DTPA). A two cell electrodializer with an initial pH of 11 and anion exchange membranes gave a strontium transfer of 74.9% in the EDTA solution, and of 46.7% in the DTPA solution. No cesium was transferred to the anode cell. A three cell electrodializer using a 0.005 molar EDTA solution at an initial pH of 11.0 retained 94% of the cesium with anion exchange membranes. When cation exchange membranes were used, 75% of the strontium was retained in the feed cell while 11% of its transferred to the cathode cell together with 81% of the cesium. It was concluded that cation exchange membranes were unsatisfactory for this process, and that EDTA provided a better separation than DTPA under above experimental conditions. G.G.

N65-34343# IIT Research Inst., Chicago, Ill.

OPTICAL SPECTRA OF SOME LOW-MOLECULAR WEIGHT COMPOUNDS USING THE MATRIX ISOLATION TECHNIQUE Quarterly Technical Summary Report, May 14–Aug. 14, 1965

Alan Snelson [1965] 10 p refs

(Contract DA-31-124-ARO(D)-111; ARPA Order 458)

(IITRI-C6013-9; AD-470060)

Continued research conducted under a program designed to determine the thermodynamic functions of low-molecular-weight compounds formed in the exhaust gases of rocket motors, is reported. Presented are results of spectral analyses performed on the LiF–BeF_2 and the Li–AlF_4 systems. Studies of the boron oxide/boron trifluoride system were initiated and a suitable all stainless steel gas inlet system with a controlled leak was fabricated to handle the BF_3. Preliminary tests indicated that the system is satisfactory. S.C.W.

N65-34344# Peninsular ChemResearch, Inc., Gainesville, Fla.

RESEARCH ON SELECTIVE FLUORINATION TECHNIQUES Quarterly Progress Report No. 7, 1 May–31 Jul. 1965

Dale A. Warner, S. N. Tsoukalas, C. L. Daffin, and B. A. Howard [1965] 29 p ref

(Contract AF 04(611)-9574; ARPA Order 24)

(Rept.-65-7; AD-470120)

In view of the consistent failure of aqueous fluorination of hydrazine and its simple derivatives to yield products containing the N-F bond, a study of possible side reactions has been undertaken. The reactions of fluorine with water, and of hydrogen peroxide with hydrazine have been studied in some detail. A full quantitative treatment has so far been precluded by analytical difficulties. The test of the importance of the side reactions is a quantitative comparison of aqueous fluorination with oxidations of hydrazines by H_2O_2 and/or oxygen. Author

N65-34347 Harshaw Chemical Co., Cleveland, Ohio. Central Research Lab.

INVESTIGATION OF THE EXISTENCE OF OXYANIONS OF FLUORINE AND NITROGEN AND THE NITROGEN–FLUORINE CATIONS Quarterly Technical Summary Report, 28 Apr.–28 Jul. 1965

Gerald L. Hurst and S. I. Khayat 28 Aug. 1965 16 p

(Contract DA-31-124-ARO(D)-76; ARPA Order 402)

(HQ-76-10; AD-468850)

Presented are results of experimental investigations of the stability of various solvents in the presence of N_2F_4, reactions of N_2F_4 with metal salts in basic solvents, and reactions of N_2F_4 in acidic solvents. Acetonitrile, phosphorus oxychloride, thionyl chloride, and acetic acid were sufficiently inert to be used for reactions of several days duration below 60°. Acetonitrile appeared to be the most stable substance. The effect of basic solvents (Lewis bases) on the rate of reaction of N_2F_4 with metal salts varied with individual mixture. The reaction of N_2F_4 with concentrated H_2SO_4 produced NF_2H in moderate

yield. In the absence of solvents at 30°, mercury slowly reduces N_2F_4 to nitrogen, while no reaction occurs in the presence of acetonitrile. Included are data on the preparation of pure NF_2H via the reaction of N_2F_4 with $FeSO_4$ in concentrated H_2SO_4. S.C.W.

N65-34348# Western Reserve Univ., Cleveland, Ohio.
THE PREPARATION AND PROPERTIES OF ORGANIC DERIVATIVES OF PEROXIDES OF PHOSPHORUS, TIN, BORON, SILICON, AND SULFUR Final Report
Ralph L. Dannley 12 Aug. 1965 7 p
(Grant DA-ARO(D)-31-124-G242)
(AROD-3342-9; AD-468448)

The first hydroperoxides of tin, the first stable hydroperoxides of silicon, the first stable bis-peroxides of silicon, the first bis-peroxide of phosphorus, and the first stable sulfonyl peroxides have been prepared. The hyroperoxides of the Group IV elements other than carbon tend to rearrange rather than react with other compounds. The kinetics, products, and energies of activation have been determined. With an increasing atomic weight of the peroxidic elements there is a decrease in activation energy for the rearrangement process. The bisperoxide of phosphorus is of reasonable stability but also tends to rearrange. Kinetic and product studies have been made of this decomposition process. Of all the sulfonyl peroxides prepared, only the nitro derivatives were safe for routine use. They substitute aromatic nuclei in 70° yield and the sulfonate esters produced hydrolyze easily. Therefore this is a promising new synthesis of phenols. Partial rate factors indicate that the substitution is an electrophilic reaction. Peroxidic copolymers of tin compounds and aldehydes and ketones are very stable and may be of value as free radical catalysts which decompose by mechanical shear. Author

N65-34354# United Kingdom Atomic Energy Authority, Harwell (England). Chemistry Div.
A LEAD SHIELDED CELL FOR HANDLING $\beta\gamma$-ACTIVE MATERIALS
P. E. Brown London, HMSO, May 1965 21 p refs
(AERE-R-4933) CFSTI: HC $1.00/MF $0.50

A versatile lead shielded cell is described together with the equipment and operating experience gained in the chemical remote handling of active materials at levels up to 10 MeV curie of γ activity. Author

N65-34357# Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires.
USE OF TRI-LAURYLAMINE DURING THE EXTRACTION OF IRRADIATED FUELS [UTILISATION DE LA TRILAURYLAMINE AU RETRAITEMENT DES COMBUSTIBLES IRRADIES]
André Bathellier, Gerard Koehly, Jean-Jacques Perez, and André Chesne Aug. 1964 57 p refs In FRENCH; ENGLISH summary
(CEA-R-2594) CFSTI: HC $3.00/MF $0.50

The purification of aqueous solutions of plutonium can be made by extraction of the Pu (IV) nitrate complex using trilaurylamine in dodecane. The principal physical properties of this solution are considered along with its extractive properties and the influence of foreign ions on the extraction. The application of this method of extraction in a processing cycle for irradiated material is proposed: either for a final purification process or for auxiliary cycles for recovering plutonium from metal production wastes, oxalate precipitation supernatants, or any general aqueous plutonium waste solution. Also proposed are clean-up procedures for regeneration of an extractive solution which has undergone chemical or radiolytic degradation. Author

N65-34364# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
RADIOLYSIS OF ION EXCHANGE RESINS USED IN THE PURIFICATION SYSTEMS OF SAVANNAH RIVER REACTORS
Elizabeth W. Baumann Jul. 1965 18 p refs
(Contract AT(07-2)-1)
(DP-977) CFSTI: $1.00

Loss of ion exchange capacity and the presence of water-soluble materials in depleted deionizer resin from a Savannah River Plant reactor system indicated the resins were degraded during service. Calculations and on-line measurements of radiation dose showed that the threshold dose for resin damage, 10^7 rad, was approached or exceeded in the deionizer beds. Sodium-24, produced by the (n,α) reaction on aluminum fuel cladding, was the major contributor to the radiation dose. Author

N65-34367# Union Carbide Nuclear Co., Oak Ridge, Tenn.
THE SEPARATION OF POTASSIUM ISOTOPES BY MOLECULAR DISTILLATION
R. M. Mc Gill, R. W. Browell, J. W. Grisard, S. Blumkin, E. Von Halle et al 29 Sep. 1965 132 p refs
(Contract W-7405-ENG-26)
(K-1650) CFSTI: $4.00

The technical feasibility of accomplishing the separation of the principal potassium isotopes K-39 and K-41 on a large scale by the molecular distillation of potassium metal has been established. Following preliminary tests, a 10-stage experimental molecular still was designed, constructed, and operated to locate the optimum operating temperature and to investigate the effect on the separation factor of several process variables. The experiment was successful and led to the design and construction of a 15-stage prototype cascade unit for operation at the optimum evaporating temperature of 270°C. Conceptual design of a molecular distillation cascade to produce one ton per year of potassium enriched to 99.93% K-39 has been completed; analysis of the cascade construction and annual operating costs leads to an estimated unit cost of product of about $420/lb. Economic effects of operating this cascade at other K-41 depletion factors and other production rates are discussed. Author

N65-34384# Eagle-Picher Co., Miami, Okla. Electronics Div.
RESEARCH IN PURIFICATION AND SINGLE CRYSTAL GROWTH OF II-VI COMPOUNDS Quarterly Progress Report, 15 Apr.–15 Jul. 1965
R. H. Fahrig, ed. [1965] 28 p refs
(Contract AF 33(615)-2947)
(QPR-1; AD-470918)

Continued research focusing on the development of techniques for use in the synthesis and purification of single crystals of group II to VI compounds is reported. Cadmium sulfide of improved purity was synthesized, and single crystals containing small amounts of Co were grown. Unexplainable increases in impurity levels occurred in several ZnS syntheses, and possible causes are being studied. Approximately 80 ZnS crystal ingots were grown from the melt. A few undoped ZnS crystals were grown by the conventional vapor phase process. Luminescence under ultraviolet stimulation was exhibited by some of these crystals and is believed to be due to copper impurity in the lattice. Approximately 2.6 kilos of ZnS were synthesized in four runs. The silicon impurity varied so widely that contamination was suspected. A literature search on the growth of HgS (red modification) crystals indicated that hydrothermal techniques might prove effective. Two methods of approach to the problem of providing Na free Li compounds are being explored. Trials of each method

indicate modest initial success, however, further studies are required to determine the Na content. Plans for the new pressure furnace which will be used to grow single crystals are being drawn. S.C.W.

N65-34510# Purdue Univ., Lafayette, Ind. School of Aeronautics, Astronautics and Engineering Sciences.
CONTINUUM THEORY OF CHEMICALLY REACTING MEDIA
John D. Ingram and A. Cemal Eringen Jul. 1965 101 p refs
(Contract Nonr-1100(23))
(TR-28; AD-469177)

The basic field equations, boundary conditions, and constitutive equations necessary for the treatment of problems concerning the nonlinear, dynamic behavior of mixtures of reacting, Stokesian fluids subject to large deformation rates, thermal gradients, and concentration gradients are derived. These are applied to the problem of propagation of small disturbances in a binary, reacting mixture. The basic equations are formulated to include the laws of conservation of mass and energy, and principles of balance of momentum, moment of momentum, and entropy. The form of the local Clausius-Duhem inequality is derived for each of the components of the mixture. The constitutive equations characterize the stress, heat fluxes, transfer quantities relating to diffusion and chemical reaction, and the internal energy and entropy. The Clausius-Duhem inequality is then used to restrict the form of the response functions appearing in these equations. Specialized forms of the constitutive equations applicable to large deformation rates and large temperature gradients but linear in the other variables are presented. Author

N65-34702# Battelle-Northwest, Richland, Wash.
SOLVENT EXTRACTION OF CESIUM FROM HANFORD ALKALINE SUPERNATE BY 4-SEC-BUTYL-2α-METHYBENEZYLPHENOL LABORATORY STUDIES
L. A. Bray Aug. 1965 20 p refs
(Contract AT(45-1)-1830)
(BNWL-68)

A cesium solvent extractant, 4-sec-butyl-2(alpha-methylbenzl)phenol, was investigated. The substituted phenol, diluted with a kerosene, was found to be a very selective extractant for cesium. The extractant provides an efficient method for cesium recovery from alkaline supernate. The extraction of cesium depends on the concentration of phenol, the pH of the aqueous waste solution, the equilibrium temperature, and the aqueous Na^+ concentration. Approximately 0.3 of a mole of additional OH^- was required per liter of synthetic alkaline supernate for maximum cesium extraction. Cesium distribution values are enhanced by an equilibrium temperature decrease. The heat of extraction was approximately 19 kcal. The cesium distribution ratio was inversely dependent on the sodium concentration with a slope of slightly less than −2 over the range of 1 to 8*M* sodium. R.N.A.

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N65-33564 New York Univ., N. Y. Geophysical Sciences Lab.
THE DETERMINATION OF THE VERTICAL PROFILE OF ATMOSPHERIC GASES BY MEANS OF A GROUND BASED OPTICAL RADAR
Richard M. Schotland *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 215–224 refs (See N65-33550 22-13)
(Contract DA-36-39-AMC-0341(E))

An analysis is presented of a remote sounding method in which the vertical distribution of absorbing gases such as water vapor and ozone may be determined. This is done by a study of the spectral distribution of the backscatter from a pulse of light generated by a vertically pointing optical radar. An experiment is described in which the measurement of the vertical distribution of atmospheric ozone was attempted using a pulsed krypton flash lamp as an energy source. A discussion is given of an optical radar system under development using a thermally tuned ruby laser source which is designed to determine the vertical profile of water vapor. Author

N65-33567 National Bureau of Standards, Boulder, Colo.
WIDTH OF THE MICROWAVE LINES OF OXYGEN AND THEIR RELATIONSHIP TO THE THERMAL NOISE EMISSION SPECTRUM OF THE ATMOSPHERE
Richard L. Abbott *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 257–269 refs Sponsored by Army Electron. Res. and Develop. Lab. (See N65-33550 22-13)

Calculations of the thermal noise emitted by the atmosphere using values of the line widths of O_2 from measurements of the line widths at very low and at atmospheric pressure, are presented. The approximate calculation of line widths of previous investigations are described briefly. Some modifications necessary to calculate the anomalous behavior of the line widths of O_2 at atmospheric and lower pressures are given. These modifications enable many calculations to be made which were previously not feasible, and the results are much more precise than previous calculations. An example of such a calculation is presented. A brief view of the kinds or atmospheric probing information which are expected to result from the investigation is given. A brief comment will be given on how atmospheric probing can help in improving our understanding of molecular collision processes. Author

N65-33572 Space-General Corp., El Monte, Calif.
MICROWAVE RADIOMETER MEASUREMENTS PROGRAM
W. H. Conway and R. T. Sakamoto *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 339–356 ref (See N65-33550 22-13)

An experimental passive microwave radiometer measurements program is described. This discussion concerns itself primarily with the nature of the experiments, the equipments used, and, above all, the resulting data. The primary objective of the program was to obtain accurate microwave measurements of the characteristics of a selected set of material surfaces, e.g., various soils, vegetation, etc., under rigorously controlled conditions. Measurements have been made at a variety of frequencies, and have also included effects of the depths of the surface material as well as the material itself. Multilayer effects with layers of different materials have also been included. Atmospheric measurements are also included. A second prime objective of the program was to provide data to be used for analysis of the characteristics of the various surfaces. Much of the data is presented compared to the predicted values. Author

N65-33577 Michigan Univ., Ann Arbor. Inst. of Science and Technology.
TARGET AND BACKGROUND SIGNATURE STUDY
T. Limperis *In its* Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 423–434 (See N65-33550 22-13)

A data collection program concerned with measurements of target and background characteristics is described. The utility of this collection to interested members of the scientific community is discussed and plans for the analysis program which will use these data are described briefly. Author

N65-33581 Barringer Research, Ltd., Rexdale (Ontario).
RECENT PROGRESS IN REMOTE SENSING WITH AUDIO AND RADIO FREQUENCY PULSES
M. Gelevnse and A. R. Barringer *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 469–494 ref (See N65-33550 22-13)

Further development of the input or induced pulse transient electromagnetic system has resulted in higher powered miniaturized equipment of improved sensitivity. Airborne programmes have proven the capabilities of the system for detecting and resolving geologic features beneath highly conductive saline soils. Ore deposits of the porphyry copper type have for the first time been detected from the air in a comprehensive test programme. Continuing development of very short pulse VHF radar mounted in a vehicle has yielded new information on the VHF reflective properties of soil under varying conditions of layering, moisture content and soil type. The feasibility has been established and the parameters outlined for an airborne low level terrain sensing system utilizing VHF pulses. Author

N65-33587 Raytheon Co., Alexandria, Va.
SOME APPLICATIONS OF SIDE-LOOKING AIRBORNE RADAR
Jay H. Simons *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 563–571 (See N65-33550 22-13)

The applicability of the AN/APQ-56 system to observation of geological structure, geomorphologic features, and cultural patterns of land uses is investigated. Author

N65-33608* AVCO-Everett Research Lab., Everett, Mass.
DETECTION OF, AND COMMUNICATION WITH SPACE VEHICLES DURING ATMOSPHERIC ENTRY; PROBLEMS IN SIMULATION
S. C. Lin *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. B [1964] 29 p refs (See N65-33604 22-30)
CFSTI: HC $6.00/MF $1.50

The problem of simulation of communication during atmospheric entry is discussed. A general description and theory of the physical phenomena associated with spacecraft reentry are given. The solution to the problem is shown to require a simultaneous treatment of fluid dynamics, chemical kinetics, and the propagation of electromagnetic waves in an inhomogeneous hypersonic flow field. C.T.C.

N65-33621# Air Technology Corp., Cambridge, Mass.
LOW FREQUENCY AIRBORNE ANTENNA SYSTEM Monthly Progress Report
4 Aug. 1964 6 p
(Contract DA-02-086-AMC-0051(E))
(MPR-3; AD-460999)

Shielding along the electrical centerline, rotor blade static discharge, and effects of rotor modulation on operational performance are mentioned. A brief discussion is also included in the areas of whip antenna design, preamplifier design, system evaluation of a short top-loaded vertical-dipole antenna, and rotor modulation from helicopter vertical rotor blades. C.T.C.

N65-33742# Boeing Co., Renton, Wash. Commercial Airplane Div.
COMPRESSOR NOISE RESEARCH
David A. Bateman, Stephen C. Chang, Bruce T. Hulse, and John B. Large Jan. 1965 102 p refs
(Contract FA-64-WA-4920)
(FAA-ADS-31)

The noise generating mechanisms of axial flow compressor blades were investigated using flat blades to facilitate mathematical analysis. Analytical expressions are given for evaluating the compressor noise due to blade thickness, loading and vortex shedding. Measured values of compressor noise show good agreement with those analytically predicted. It was found that lift or loading noise dominates over blade thickness and vortex noise. Rotor-stator spacing and clearance between the rotor blade tips and the duct are important parameters in the generation of rotor noise. Author

N65-33746# Michigan Univ., Ann Arbor. Cooley Electronics Lab.
HIGH-GAIN, LOW-FREQUENCY ANTENNA SYSTEM Progress Report, 1 Jan.–1 Mar. 1965
Richard Vaughan [1965] 10 p
(Contract DA-02-086-AMC-0106(E))
(PR-4; AD-463779)

A crossed-loop oblate-spheroidal ferrite-cored antenna was considered for use with Loran C equipment together with a suitable negative feedback preamplifier. Ultimate theoretical limits to the sensitivity of the system were established. Methods of achieving an omnidirectional antenna were considered. It is recommended that a manually controlled electrically steerable directional antenna be used instead. R.N.A.

N65-33748# National Bureau of Standards, Boulder, Colo. Central Radio Propagation Lab.
ATLAS OF FOURIER COEFFICIENTS OF DIURNAL VARIATION OF foF2. PART II: DISTRIBUTION OF AMPLITUDE AND PHASE
William B. Jones and Roger M. Gallet 14 Feb. 1965 120 p refs
(NBS-TN-305) GPO: $0.60

This atlas is devoted to the study of amplitude and phase from the diurnal analysis of foF2 monthly median. It is concerned with their variations—both systematic and random—as functions of latitude, season and solar activity. The atlas contains a series of graphs of the distribution of amplitude and phase and tables of phase distribution for four seasonal months of high and low years of solar activity. Emphasis is placed on the study of the phase distributions for determining the optimum separation of harmonics produced mainly by noise from those representing mostly real physical variation. Author

N65-33749# ITT Gilfillan, Inc., Los Angeles, Calif.
A DESIGN STUDY OF AN ANTENNA FOR AN AIR-TRANSPORTABLE TACAN GROUND STATION
L. N. Shestag and D. L. Thomas Bedford, Mass., AFSC. Electron. Systems Div., Jul. 1964 131 p refs
(Contract AF 19(628)-3824)
(SDC/1.1.500-C; ESD-TDR-64-526; AD-355656)
(Declassified)

This report summarizes work conducted during a design study for an air-transportable TACAN ground station antenna. The objectives of the study were the establishment and complete analysis of a system technique and a paper design for an experimental model. An antenna system technique was defined, extensive computer simulation, breadboard testing of critical system components, and designing of an experimental model antenna were accomplished. The result of the study defines a practical antenna which is all solid state, electronically scanned, and which offers significant improvement in the operational usefulness of the TACAN system. It is recommended that work on this technique be continued with development of an experimental model antenna system. Author

N65-33852*# Hughes Research Labs., Malibu, Calif.
INVESTIGATION OF RF NOISE GENERATION FROM SPACE VEHICLES Quarterly Report No. 5, 24 Jul.–24 Oct. 1962
Robert D. Wanselow [1962] 22 p refs
(Contract NAS8-862)
(NASA-CR-64907) CFSTI: HC $1.00/MF $0.50 CSCL 17B

Investigation continued on a program to determine analytically and experimentally the power spectrum of noise generated by electrical propulsion devices, with emphasis on the cesium ion engine. Investigations to date on cesium ion engines have exhibited no noise from the ion beam in the 38 to 2200 Mc spectrum. However, initial tests of a Penning engine have exhibited noise radiation in the vicinity of the electron cyclotron frequency and the electron plasma frequency. Analytical studies of a possible noise growth mechanism in a narrow band about the electron plasma frequency do indicate that it may be possible to generate rf interference. Therefore, communications systems should probably be operated above the cyclotron and plasma frequencies. In this higher frequency range there is a definite reduction in plasma noise, and the conductive properties of the plasma will have less effect on antenna patterns. R.N.A.

N65-33901# National Bureau of Standards, Boulder, Colo. Central Radio Propagation Lab.
OPTICAL SCINTILLATION; A SURVEY OF THE LITERATURE
Jurgen R. Meyer-Arendt and Constantinos B. Emmanuel 5 Apr. 1965 145 p refs
(NBS-TN-225) GPO: $0.70

Numerous observational, experimental, and theoretical aspects of random refraction, that is, of scintillation in its widest sense, are discussed. The following topics are dealt with: refraction in plane and in spherically stratified media, refractive index variations, radio refraction, scintillation as a function of aperture size, zenith distance, site location, dispersion, and meteorological conditions, the frequency spectrum of scintillation, terrestrial scintillation, image distortion and contrast reduction, refraction and diffraction theories of scintillation, autocorrelation analyses, radio star scintillation, and coherence problems. Questions of atmospheric scattering, absorption, and depolarization are excluded. Finally, a brief review is given concerning newer experimental methods for the observation, recording, and analysis of optical scintillation, including suggestions as to what further theoretical and experimental efforts should be undertaken. Author

N65-33959*# National Aeronautics and Space Administration, Washington, D. C.
BASIC OPERATING LIMITS ON COMMUNICATION LINKS WITH SPACECRAFT
Johannes Peters Sep. 1965 23 p refs Transl. into ENGLISH of "Zur Fundamentalen Leistungsgrenze von Nachrichtenverbindungen mit Raumfahrtzeugen" Deut. Gesellschaft für Raketentech. und Raumfahrtforsch. (Stuttgart) Presented at the Symp. on Data Transmission and Navigation, Munich, 8 Apr. 1965
(NASA-TT-F-9560) CFSTI: HC $1.00/MF $0.50 CSCL 17B

Space communications can be defined in terms of information theory, thermodynamics and wireless energy transmission. Information theory is applicable if an alphabet is present and if a probability is associated with each letter of this alphabet. The concept of information is defined and several examples are given. The concept of entropy in thermodynamics is shown to be very closely associated with space communications. This is due to the fact that each letter in information theory is made up of fundamental building blocks which have an entropy associated with them according to Boltzmann's equation. The practical limitations of wireless energy transmission show that the maximum communication distance is $1.14 \cdot 10^{13}$ km, somewhat more than a light year. Author

N65-33963*# Consultants and Designers, Inc., Arlington, Va.
TENTATIVE ESTIMATE OF THE THRESHOLD RESPONSE OF A TELEVISION SYSTEM FROM STELLAR OBSERVATIONS [OPYT OTSENKI POROGOVOY CHUVSTVITEL'NOSTI TELEVIZIONNOY SISTEMY PO NABLYUDENIYAM ZVEZD]
A. N. Abranenko, E. S. Agapov, V. F. Anisimov, Yu. S. Yefimov, V. B. Nikonov et al [1965] 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 161, no. 6, 1965 p 1299–1300
(Contract NAS5-3760)
(NASA-TT-F-9689; ST-RA-10347) CFSTI: HC $1.00/MF $0.50 CSCL 17B

By tentatively estimating the threshold response of a television system from stellar observations, the authors show that the use of a highly sensitive television system allows the registration of radio emission from stars of 20 to 21^m by means of an average-size telescope and an exposure time from a few seconds to one minute. This is close to the theoretical limit of observations of light fluxes of limit small values. Therefore, the use of television method opens broad possibilities for the observation of fast processes in stars. Author

N65-33982# Stanford Research Inst., Menlo Park, Calif.
HF TIME- AND FREQUENCY-DISPERSION EFFECTS–EXPERIMENTAL VALIDATION OF AN FSK ERROR-RATE MODEL
B. M. Sifford, H. N. Shaver, R. F. Daly, and K. D. Felperin Mar. 1965 236 p refs
(Contract DA-36-039-SC-90859)
(TR-4; AD-618330)

An experiment has been conducted to determine the sensitivity of an HF FSK communications system to time- and frequency-selective fading phenomena. Binary error rate was measured on AN/FGC-29 teletype terminal equipment over an HF path from Fort Monmouth, New Jersey to Palo Alto, California in the fall of 1964. Simultaneous measurements were made of channel signal-to-noise ratios, channel time-delay profiles, channel Doppler-shift profiles, and signal correlation between spaced antennas. Instrumentation included a phase-stable transmitter-receiver, an oblique-incidence ionospheric sounder, and a special correlation meter. The measured error rates were compared to those predicted by a mathematical model. The model for the channel considers randomly time-varying and frequency-selective effects appropriate for the HF propagation mechanism. The system model

approximates the AN/FGC-29 system. Theoretical and measured error-rate curves are presented and discussed. Measured system performance showed a well-defined sensitivity to channel time- and frequency-selective effects. The asymptotic error rates measured at high signal-to-noise ratios are in reasonable agreement with those predicted from the model. Author

N65-34152# Norwegian Defence Research Establishment, Kjeller.
LONG RANGE PROPAGATION STUDIES Technical Report, Mar. 1962–Sep. 1964
K. Folkestad 17 Nov. 1964 46 p refs
(Contract AF 61(052)-610)
(E-44; AFCRL-65-163; AD-619877) CFSTI: HC $2.00/MF $0.50

This report describes the activity associated with step-frequency oblique soundings in Norway during the period from March 1962 to September 1964. Experimental data are given. General considerations pertaining to oblique soundings are presented, along with a brief review of some related works performed hitherto. Theoretical deductions elaborated from a set of models are described. Characteristic observational features are illustrated by means of selected examples, and explanations are offered when possible. The communicational aspect of the experiments is dealt with in one of the chapters. Author

N65-34176# Litton Systems, Inc., Waltham, Mass. Information Sciences Lab.
PHASE COHERENT M-ARY TRANSMISSION WITH BINARY WAVEFORMS THROUGH A GAUSSIAN CHANNEL Scientific Report No. 1
William B. Floyd and Albert H. Nuttall Bedford, Mass., AFCRL, 1 May 1965 101 p refs
(Contract AF 19(628)-4081)
(AFCRL-65-434; AD-619493)

A generic digital communication method, called "q-M-ary transmission," is introduced and evaluated under the special conditions of phase coherent reception of signals transmitted through a non-fading medium. The basic feature of this method is the use of M-ary transmission alphabets, but employing only q different waveforms to synthesize the transmitted signals. Special attention is directed to the effect of bandwidth constraints on the performance attainable with this method, and to the value of high order M-ary transmission alphabets, when implemented with this method. Comparison of a particular form of this method (q = 2) with conventional binary coding indicates that at least a few db improvement is provided by the 2-M-ary method with M large, even when bandwidth is severely limited. A variety of results have been obtained in an intermediate step toward evaluating q-M-ary systems, which may prove useful for evaluating a wide variety of M-ary systems. Of particular importance are general relations between the degree to which pairwise correlation between transmitted signals can be made small, and the degree to which bandwidth is constrained. Author

N65-34177# Air Force Cambridge Research Labs., Bedford, Mass. Microwave Physics Lab.
DIRECTIVITY AND BEAMWIDTH APPROXIMATIONS FOR LARGE SCANNING DOLPH–CHEBYSHEV ARRAYS Physical Sciences Research Papers No. 117
Charles J. Drane, Jr. Jun. 1965 32 p refs
(AFCRL-65-472; AD-619808)

Approximate but accurate formulas are presented here in closed form, for the purpose of easy examination and computation of directivity and beamwidth for large scannable Dolph-Chebyshev arrays. Array length, number of array elements, the spacing of these elements, and the side-lobe level desired are parameters in this study. The maximum achievable directivity for Chebyshev arrays is in principle limited, regardless of how large the array becomes. Data are given to establish the array length required to obtain a value of directivity at some prescribed level below the maximum value. Comparisons between exact and approximate theory are presented in graphical form in such a way as to illustrate the lower limits of array size for which the approximations are valid. Element spacings less than a half-wavelength are included in this study. Author

N65-34182# Philco Corp., Blue Bell, Pa. Ground Based Radar Lab.
NON-PLANAR ARRAY "THINNING" STUDY Final Report
Charles E. Clarke and Thomas J. B. Shanley Griffiss AFB, N. Y., RADC, Jun. 1965 133 p refs *Its* Rept.-2594-F
(Contract AF 30(602)-3337)
(RADC-TR-65-129; AD-619688)

This is the final technical report on an investigation to establish guidelines for the design of thinned phased array antennas of spherical configuration. The array designs investigated would have approximately 100,000 elements if completely filled and are thinned from 50% to 90%. Different degrees of element directivity and amplitude taper were considered. (Space taper is not practicable with this type of array). The main accomplishments of this program are: (a) the evolution of a systematic method of positioning many approximately equispaced elements on a sphere, and the preparation of a computer program to obtain the coordinates of these locations, for a filled-in array of approximately 100,000 elements, (b) development of spherical array designs based on alternative constrained random thinning methods, and generation of sample array patterns on a digital computer, (c) development of analytical techniques which predicted the important pattern parameters of statistically thinned spherical arrays in close agreement with computer data, and (d) a theory predicting the pattern parameters of statistically thinned spherical arrays, which takes the amplitude and phase errors of the elements into account. Author

N65-34194# Library of Congress, Washington, D. C. Aerospace Technology Div.
TRACKING OF MISSILES AND SPACE VEHICLES, COMPILATION OF ABSTRACTS Surveys of Soviet-Bloc Scientific and Technical Literature, Nov. 1964–Mar. 1965
14 Sep. 1965 50 p refs *Its* Rept.-24
(ATD-P-65-51)

Abstracts of 28 Soviet papers on topics related to tracking of missiles and space vehicles are presented. The abstracts are grouped under the headings "ion clouds and ionospheric perturbations" and "radio astronomy: radio emission, antennas, and lasers and masers." A bibliography of 61 Soviet papers is included. J.M.D.

N65-34214# Joint Publications Research Service, Washington, D. C.
DETECTION CHARACTERISTICS
M. S. Katsenbogen 23 Sep. 1965 64 p refs Transl. into ENGLISH of "Kharakteristiki Obnaruzheniya (Moscow), Soviet Radio Press, 1965 p 1–69
(JPRS-32123; TT-65-32616) CFSTI: $3.00

This monograph presents radar detection characteristics (graphs of detection probability as a function of normed range) for a wide range of values of the number of integrated pulses and the false alarm probability. Account is taken of the nature of the flickering signals reflected from the real target, various

methods of radiating the interrogating energy and the technique for the processing of the signal (single signal, continuous radiation, coherent and noncoherent signal trains). The theoretical material presented in the two chapters clarifies the principles used in obtaining the computed graphs. The charts can be a useful aid in various sorts of calculations in which the radar detection range is determined as a statistical quantity. The book is intended for engineers involved with system analysis, design and operation of radar equipment and for students specializing in this field. Author

N65-34215# Boeing Scientific Research Labs., Seattle, Wash.
PERMANENTLY MAGNETIZED FERRITE ANTENNA WINDOWS FOR IMPROVING ELECTROMAGNETIC WAVE TRANSMISSION THROUGH A PLASMA
M. J. Kofoid Jun. 1965 16 p refs
(DI-82-0442; AD-618381)

A longitudinal magnetic field (B_z) can be employed to increase the transmission through a plasma of a right-hand polarized electromagnetic (EM) wave at below the natural plasma frequency. The B_z field can be produced by permanently magnetized ferrite material in the form of a thick sheet placed as a window in front of the radiator and directly adjacent to the plasma. The crucial point is that it has been shown by test that high-frequency EM waves can be transmitted with only reasonable attenuation through a thick sheet of ferrite which is now producing a $B_z > 1500$ gauss longitudinal field at the sheet surface. Further, due to its rotational field-displacement properties, there exists the possibility that the magnetized ferrite sheet serving as the antenna window may be so constructed as to be simultaneously an isolator and thereby reduce the changes in load impedance seen by the radiator with varying plasma sheath conditions. Author

N65-34241*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
APOLLO DIGITAL UP-DATA LINK DESCRIPTION
Stuart D. Lenett Washington, NASA, Oct. 1965 53 p refs
(NASA-TM-X-1146) CFSTI: HC $2.00/MF $0.50 CSCL 09F

This document describes the digital up-data link equipment used on the Apollo command module. It is written in two parts: the first section is a general description of the equipment and its functions, and the second is a detailed description of the circuitry which makes up each subassembly and its individual unique function. This equipment, although similar to that used on the Gemini spacecraft, has had some major modifications; consequently, a description of the Gemini Digital Command System does not fit that of the Apollo Up-Data Link. The Apollo Up-Data Link Equipment is a digital system comprised of three subassemblies, a UHF receiver, a sub-bit detector and a decoder. The hardware is approximately 13.00 inches by 9.38 inches by 4.41 inches in size and weighs less than 20 pounds. It will fit in the lower equipment bay of the Apollo command module and operate from the spacecraft +28 V dc supply. The Up-Data Link will have the capability of interfacing with the Apollo guidance computer, central timing equipment, real-time command relays, and the PCM system. It will also be capable of receiving inputs from either a UHF receiver at a frequency range of 406 to 450 Mc or from an S-band receiver through the premodulation processor. Author

N65-34242*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
BANDWIDTH OPTIMIZATION FOR FREQUENCY SHIFT KEYING
James C. Morakis Washington, NASA, Sep. 1965 41 p refs
(NASA-TN-D-3000) CFSTI: HC $2.00/MF $0.50 CSCL 09F

The behavior of a frequency shift keying detector as a function of bandwidth has been analyzed for four types of band pass filters, and bit error probability curves have been plotted for each of the four filters with the bandwidth as the variable. The four filters are: (a) a dump type, (b) a sharp type, (c) a combination of a and b, and (d) a singly tuned high Q filter. The purpose of this paper is to bring out the variation of optimum bandwidth as the assumptions about the system vary. Another significant result is the unbalance of the probability of error due to different binary combinations, and consequently, the dependence of the average probability of error on just the probability of error of two out of 2^k combinations. Author

N65-34298# Illinois Univ., Urbana. Radiolocation Research Lab.
[RADIOLOCATION RESEARCH LABORATORY] QUARTERLY MANAGEMENT REPORT, JULY, AUGUST, SEPTEMBER 1964
E. C. Hayden et al [1964] 16 p refs
(Contracts NObsr-85243; NObsr-89229; Nonr-1834(02); AF 30(602)-2413)
(RRL-270; AD-464727)

Brief summaries of research in antenna array systems are presented. Areas covered include: test and evaluation of full scale antenna arrays, diversity techniques for Wullenweber arrays, reflectometer accuracy studies, twin channel receiving systems, ionosphere measurement, band array studies, servo systems, and rotating display systems. G.A.L.

N65-34341# Navy Electronics Lab., San Diego, Calif.
COUPLER GROUPS FOR HF RECEIVING ANTENNAS
W. M. Chase, I. C. Olson, and A. L. Rhiner 11 Jun. 1965 29 p
(NEL-1295; AD-469405)

Research to develop receiving antenna coupler groups to cover the hf spectrum, each of which will provide several receiver channels in its frequency range; and to design a suitable combining network to connect the several antenna coupler inputs to a single broadband antenna, is reported. Antenna coupler groups for receiving were designed for the following frequency ranges: 2- to 6-Mc/s, 4- to 12-Mc/s, and 10- to 30-Mc/s. Also designed was a combining network design. Measurements of rejection, input impedance, and interaction, demonstrated that: (1) rejection by any receiver channel of a frequency ±10% away from resonance is approximately 60-dB when the combining network is terminated in a design antenna impedance of 50-ohms; (2) insertion loss varies between 7- and 3.5-dB, depending upon frequency, when the combining network is terminated in the design impedance; and (3) interaction between antenna couplers is not apparent until frequency separation is less than ±3%. Proposed individual antenna coupler drawers can be adapted for use as tunable filters. Equations derived from a filter circuit successfully used in Fleet quick-fix applications are included. S.C.W.

N65-34349# Harvard Univ., Cambridge, Mass. Cruft Lab.
THE ELECTROMAGNETIC FIELD NEAR A PARASITIC CYLINDRICAL ANTENNA
Ronold W. P. King and Tai Tsun Wu 18 Jun. 1965 28 p refs
(Contract Nonr-1866(32))
(TR-474; AD-466442)

The total electromagnetic field near a highly-conducting cylindrical antenna of finite length excited by a plane electromagnetic wave with the electric vector E_z^i parallel to the axis of the cylinder is investigated. The integral equation for the current in the cylinder is transformed into an integral equation for the axial component $E_z(\rho, z)$ of the electric field. This equation is solved approximately and an explicit formula

for $E_z(p, z)$ is derived. This together with the simply obtained expressions for $B_\phi(p, z)$ and $E_\rho(p, z)$ gives the complete electromagnetic field near a conducting cylinder. Author

N65-34405*# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
GENERATION AND MEASUREMENT OF NONSTATIONARY RANDOM PROCESSES Technical Note No. 3
Roger P. Webb, Joseph L. Hammond, Jr., Richard E. Bryan, and Thomas M. White, Jr. 22 Jul. 1964 60 p refs
(Contract NAS8-2473)
(NASA-CR-67115) CFSTI: HC $3.00/MF $0.50 CSCL 20N

Generation and use of nonstationary stochastic processes are considered in relation to Monte Carlo studies using an analog computer. A general method is outlined for the synthesis of analog computer circuits which, when excited by stationary Gaussian white noise, produce nonstationary random outputs with prescribed first and second statistical moments. A system for the measurement and processing of the nonstationary random processes, and an error analysis to give confidence level criterion for use with the measured random data are included. Several examples of computer circuits are constructed to realize given covariance functions; these examples illustrate the use of the synthesis procedure and analog implementation. M.W.R.

N65-34412*# Harvard Univ., Cambridge, Mass. Cruft Lab.
[ELECTROMAGNETIC RADIATION, COMMUNICATIONS, AUTOMATIC CONTROL, AND SOLID STATE PHYSICS RESEARCH] Semiannual Progress Report No. 69, 1 Jul. 1964–1 Jan. 1965
30 Mar. 1965 102 p refs Sponsored in part by NASA
(Contracts Nonr-1866(07); Nonr-1866(16); Nonr-1866(32))
(NASA-CR-67154) CFSTI: HC $4.00/MF $0.75 CSCL 20N

The following studies are reported: *Very Low Frequency Propagation*—Omega implementation, phase correction as function of time, and effects of dispersion upon group velocity of propagation; *Electron and Solid State Physics*—maser spectrometer, stimulated Raman effect in solids, etc.; *Automatic Control*—control systems, optimal programing of multivariable control systems, optimal control for dynamics systems, and topics in automatic control; *Communications and Network*—transmission-line distributed amplifier using field effect transistors, and communication theory; *Microwave Application of Ferromagnetic and Ferroelectric Materials*—magnetic relaxation by parallel pump techniques, and ferromagnetic resonance at high power in metals; *Electromagnetic Radiation*—cylindrical antenna with arbitrary driving point, optimization of curtain arrays, theory of coupled long antennas, junction between perfect and imperfect conductors, and other studies. G.G.

N65-34415*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE EFFECT OF THE INTERPLANETARY MEDIUM ON S-BAND TELECOMMUNICATIONS
M. Easterling and R. Goldstein 1 Sep. 1965 14 p refs
(Contract NAS7-100)
(NASA-CR-67065; JPL-TR-32-825) CFSTI: HC $1.00/MF $0.50 CSCL 17B

The space within our solar system, which is normally thought of as being empty, we know, in reality, is not, although it is extremely tenuous. Consideration of the accumulated effects on microwave signals traveling through many millions of miles of space becomes important. Mechanisms have been theorized for the generation of multipath, rotation of polarization, deflection, attenuation, and other telecommunication problems in space. There is no a priori way of assessing the magnitude of the effects of the interplanetary medium on telecommunications. However, since the advent of radar astronomy, we have a method of measuring these influences under the actual conditions of interest. The medium has been tested by sending waves through it, then analyzing the echoes reflected from the planets. The techniques used and the results obtained at S-band over a considerable area of the plane of the ecliptic are described in this paper. Author

N65-34450# Illinois Univ., Urbana. Electrical Engineering Research Lab.
RESEARCH STUDIES ON PROBLEMS RELATED TO ANTENNAS Quarterly Progress Report, 1 Mar.–31 May 1965
Jun. 1965 48 p refs
(Contract AF 33(657)-10474)
(QR-11; AD-467629)

In studies on radiation from periodic antenna structures, k-β diagrams with both real and imaginary parts of β were obtained for a series stub and resistor combination corresponding to the parameters of a measured dipole array. In work on log-periodic cavity-backed slot antennas, a new type of feed system having the same relative phasing as a prior feed system but lacking the stopband phenomena, was designed and tested. Near-field amplitude plots for the uniform free-space array, far-field radiation patterns of the antenna taken in the H-plane, and the impedance of the antenna plotted with respect to 50 ohms are presented. Other work is discussed for logarithmic spiral antennas, multi-arm logarithmic spiral antennas, an integrated antenna amplifier, and omnidirectional and steerable beam antennas. Wave propagation along helical conductors, is also discussed, and an integrated antenna amplifier is described. Other periodic and log-periodic structures are also investigated. L.S.

N65-34532# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Electrophysics Dept.
DIFFRACTION AND SCATTERING OF ELECTROMAGNETIC WAVES IN ANISOTROPIC MEDIA
Benjamin Rulf 26 Apr. 1965 137 p refs
(Contract AF 19(628)-2357)
(PIBMRI-1262-65; AFCRL-65-429; AD-618689)

Several two-dimensional problems for scattering and diffraction of electromagnetic waves in anisotropic media are studied. A multipole expansion is used in the low-frequency range. It is demonstrated that the rigorous solution for the problem of the scattering of a plane or cylindrical wave by an obstacle which is small compared to the wavelength may be expanded in a series whose terms correspond to multipole radiation in the anisotropic medium. In the high frequency range, geometrical optics, the first order asymptotic solution of Maxwell's equations is considered first. The ray refractive index is calculated, and the laws of propagation and reflection of rays, which define the trajectories of energy transport, are derived from Fermat's principle. The purpose of the study is to generalize mathematical methods applicable in isotropic regions to a certain class of anisotropic problems, and to study the solutions of the problems so that certain common properties which point the way toward the construction of approximate solutions for configurations with more general structural shape or anisotropy are highlighted. L.S.

N65-34565# Brown Univ., Providence, R. I. Div. of Engineering.
RADIATION FROM A TERMINATED PARALLEL PLATE STRUCTURE WITH TWO INTERACTING DISCONTINUITIES
Jacobo Farber and Carlos M. Angulo Jun. 1965 68 p refs
(Contract AF 19(628)-2498)
(AF-2498/7; AFCRL-65-333; AD-619686)

Radiation and impedance characteristics of two parallel plate waveguides, with a common center conductor, protruding a finite distance over an infinite ground plane, were studied. The problem of antisymmetric excitation was formulated by means of two coupled integral equations, involving the unknowns of the radial electric field at the aperture, and the angular component of the electric field at the termination of the protruding plane. The coupled integral equations were reduced to an infinite system of equations with infinite numbers of unknowns, and the criterion for the truncation was formed from the convergence properties of the model expansion. Variational expressions for the driving point input admittance are given for symmetric, as well as antisymmetric types of excitation. G.G.

N65-34573# Federal Aviation Agency, Washington, D. C. Systems Research and Development Service.
FUTURE SATELLITE COMMUNICATION SUBSYSTEM INVESTIGATION Interim Report
O. J. Dezoute Jul. 1965 25 p refs
(RD-65-77; AD-619725)

This report contains a review of achievements in the investigation for the over-ocean communication subsystem of the future. The results and conclusions of studies and other activity are summarized and discussed to provide observations that assist in the direction of future activity. It is recognized that implementation of a satellite relay after 1970, while economically reasonable in comparison to competitive subsystems, will require unusual consideration of trade-offs and cost/benefit and complex coordination for even the simplest application. Author

N65-34679# Air Force Eastern Test Range, Patrick AFB, Fla.
MISSILE ANTENNA DATA REQUIREMENTS
Vincent G. Huston 15 Jun. 1965 71 p refs Supersedes AFETR-REG-80-14, 19 Nov. 1959
(AFETRM-80-5; AFETR-REG-80-14)

A manual is given which defines requirements, establishes responsibilities, and prescribes procedures for submission and evaluation of missile antenna performance characteristics. Magnetic tape, paper tape, and tabulated data formats are included. C.T.C.

N65-34690# Lincoln Lab., Mass. Inst. of Tech., Lexington.
STATISTICAL SYNTHESIS OF A pP-WAVE ENHANCER Technical Note No. 1965-22
Robert Price 14 Jun. 1965 10 p ref
(Contract AF 19(628)-500)
(ESD-TDR-65-235; AD-617951)

This note provides a communication-theoretic rationale for a successful nonlinear processing scheme by showing its resemblance to minimum-rms-error estimation. The latter filtering, although "optimum" under certain assumptions, is rather more complicated in its implementation. As in all such filtering studies, the mean-square error is made up of bias, or signal distortion, and variance (which in linear filtering is attributable only to the noise). It would be interesting to see whether the filtering developed here could be modified to allow a controlled tradeoff between these two sources of error. Author

N65-34710# Naval Research Lab., Washington, D. C.
ATMOSPHERIC NOISE POWER AVAILABLE AT THE OUTPUT OF AN ELEVATED RADIOMETER ANTENNA
O. D. Sledge Jun. 1965 24 p refs
(NRL-MEMO-1619; AD-618713)

Formulae are developed for the atmospheric noise power available at the output of an airborne radiometer antenna of narrow beamwidth. The theoretical model chosen for the antenna possesses characteristics which are fairly representative of the radiators met in practice. In a numerical example, in which the beam depression angle is taken to be 30 degrees, the theory is applied to the calculation of the atmospheric path attenuation and the effective atmospheric noise temperature of the elevated antenna for a number of frequencies and antenna heights. The path attenuation varies from 0.2 db at 5000 feet of altitude and a frequency of 35 gc to 1.7-2.5 db at heights of 30,000 feet or more and at frequencies of 80 to 100 gc. The effective noise temperature of the antenna is 20° K at 10,000 feet altitude and at a frequency of 35 gc. As the frequency is elevated to 75 gc, the altitude remaining at 10,000 feet, the noise temperature of the antenna increases to 80° K. Author

N65-34716# Lockheed Missiles and Space Co., Sunnyvale, Calif.
WIDEBAND FM TRANSMITTERS AND RF-TO-RF REPEATERS FOR SPACE APPLICATIONS
R. T. Murphy [1965] 29 p refs
(LMSC-5-13-65-11; AD-618051)

This report discusses the design philosophy of wideband FM transmitters and RF repeaters for space applications in the S-band and X-band frequency ranges. The salient features of several transmitter configurations, including direct RF generation at the output frequency, are compared. The discussion shows the solid state microwave oscillator to be a logical choice to generate a wideband FM signal for space applications. Back-to-back repeaters, heterodyne repeaters, and reflex repeaters are compared for use in a satellite communication relay link. The RF-to-RF repeater, utilizing a traveling wave tube in a reentrant or reflex mode, is shown to give superior performance for space missions requiring broadband, multiple-access capabilities. Author

N65-34721# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AUTOMATIC SYSTEM FOR RECORDING THE AMPLITUDE AND PHASE CHARACTERISTICS OF DIAGRAMS OF ANTENNA DIRECTIONALITY
I. N. Kuligin and I. K. Fadeyev 28 Jul. 1965 6 p Transl. into English from Russian Patent no. 163224 (Appl. no. 784909/26-9, 3 Jul. 1962) 2 p
(FTD-TT-65-499/1+2+4; AD-619316)

The diagram for a proposed automatic device able to record amplitude and phase characteristics of directionality antenna diagrams is shown and discussed. This automatic device is provided with a servo system for measuring the independent coordinate and the displacement of the tape simultaneously with the recording of the amplitude and phase diagrams. G.G.

N65-34723# Lincoln Lab., Mass. Inst. of Tech., Lexington.
ATMOSPHERIC DISPERSION OF A WIDE BANDWIDTH RADAR SIGNAL DESIGNED FOR PULSE COMPRESSION Technical Note No. 1965-27
Sidney L. Borison 9 Jul. 1965 19 p ref
(Contract AF 19(628)-5167; ARPA Order 498; Proj. Defender)
(ESD-TDR-65-307; AD-619151)

Dispersion of a wide-bandwidth radar signal by a static atmosphere is considered. Using experimental data to fit the attenuation (in db/km) due to molecular resonances, the index of refraction may be inferred. The dispersive delay due to two-way propagation through the atmosphere is then compared

to the dispersion one would normally design for a pulse compression is quite small unless the center frequency is near the lowest water vapor resonance at $\lambda = 1.35$ cm. Author

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N65-33624# Aerospace Corp., El Segundo, Calif. Applied Mechanics Div.
DATA STRUCTURING AND DEFINITIONS FOR COMPONENT PARTS INFORMATION RETRIEVAL
Martin Barbe 1 Aug. 1964 45 p refs
(Contract AF 04(695)-269)
(TOR-269(4307)-1; AD-460974)

This report combines a general discussion of component parts data handling with specific suggestions on a data consolidation procedure in current use. The discussion is slanted towards the particular needs and problems of the Interservice Data Exchange Program (IDEP): designing a voluntary system to be contributed into and utilized by over 100 contractors. However, compatibility can still be maintained with the complex systems practical for centrally staffed information banks. The report discusses the increasing degrees of rigidity possible in structuring the parts data found in the IDEP system, and comments on the degree considered appropriate to the probable stages of utilization. Author

N65-33717*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A LOW-POWER ANALOG-TO-DIGITAL CONVERTER
Thomas B. Fryer and Charles W. Beck [1964] 12 p Submitted for Publication
(NASA-TM-X-51840) CFSTI: HC $1.00/MF $0.50 CSCL 09B

An accurate, low-power, analog-to-digital converter has been designed for use in a space vehicle experiment. Since analog-to-digital converters are required in many other applications, the circuit described is considered to be of more general interest than the particular use described. The readout is eight-bit binary with stages interconnected to give serial shift-register output as well as parallel output. The system should be useful for any application requiring a miniature, low-power, digital voltage readout. Author

N65-33732# Army Missile Command, Huntsville, Ala. Electrodynamics Branch.
A CENTER-OF-MASS COMPUTER
Michael Sakellarides 1 Jul. 1965 19 p
(RE-TR-64-14; AD-468461)

A special-purpose computer, termed the Center-of-Mass Computer (COMC), has been designed, fabricated, and integrated with other elements of an Optical Discrimination System. In operation, the COMC receives positional information from an Automatic Digital Optical Tracker (ADOT) having a multitude of objects within its optical field of view. Computations are performed from which the centroid of the objects is determined and signals are produced to position a two-axis mount containing an optical sensor. An introduction to the problem is presented, along with specifications, design objectives, logic design, and an analysis of the design. Author

N65-33744# Radio Corp. of America, Moorestown, N. J. Missile and Surface Radar Div.
[PULSE FORM DIGITIZER] Final Report
29 Jan. 1965 20 p
(Contract DA-01-021-AMC-11171(Z); ARPA Order 51)
(AD-463773)

A programmable film reader (PFR) for the point by point digital analysis of film pulse waveforms was fabricated, tested, and put into operation. The film reading system is automatic, allows a wide range of films to be read with compatible digital outputs varying with the user's need, and has more speed, precision, and accuracy than manual film reading techniques. Acceptance testing of the system was performed by observing digitization and plotting of radar film data. The system was found acceptable. The PFR system is currently reading and analyzing DAMP reentry film on a production basis for subsequent computer analysis and examination. R.N.A.

N65-33753# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MACHINES THAT CAN LEARN TO RECOGNIZE PATTERNS
V. A. Yakubovich 21 May 1965 48 p refs Transl. into ENGLISH from Metody Vychisleniy Katedra Vycheslitelnoy Mat. i Vycheslitelnyi, Tsentr. Leningrad Univ., (Leningrad), no. 2, 1963 p 95–131
(FTD-TT-65-148/1+2; AD-618643)

This translation discusses machines that in some sense simulate the work of that part of the cerebral cortex that supervises organization of impressions and processes the elementary ideas associated with pattern recognition. TAB

N65-33779# Brookhaven National Lab., Upton, N. Y.
DIGITAL READOUT CIRCUITS FOR WIRE SPARK CHAMBERS
W. A. Higinbotham, J. F. Jacobs, and H. R. Pate [1964] 9 p refs
(Contract AT(30-2)-GEN-16)
(BNL-8519; CONF-799-1)

Wires of wire spark chambers or hodoscope planes are individually threaded through magnetic memory cores, which are set by the spark currents. Only a small fraction of the wires are struck by the sparks of one event, so that it is practical to generate addresses for those cores which have been set. Circuits are described which scan the cores sequentially, 32 at a time, generating addresses and transmitting them to a buffer store or to a computer. A certain minimum time, in this case determined by the transit time of signals in cables, is required to scan the cores. A small additional time is required to generate and store each address. Any number of sparks may be handled in one event, and checking features have been incorporated in the system. R.N.A.

N65-33879*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A STUDY OF THE EFFECTIVENESS OF FAULT-DETECTING CODES FOR BINARY ARITHMETIC
Algirdas Avizienis 1 Sep. 1965 43 p
(Contract NAS7-100)
(NASA-CR-64882; JPL-TR-32-711) CFSTI: HC $2.00/MF $0.50 CSCL 09B

The effectiveness of a class of low-cost fault-detecting codes for binary arithmetic is investigated. Causes of arithmetical errors are studied, and error magnitudes are related to logic faults and to the arithmetic algorithms of the processor. The effectiveness of the fault-detecting codes is considered for three types of logic faults. Cases of one-use and of repeated

use of the faulty logic element during an algorithm are investigated separately. Fault location and the application of several check factors are developed as extensions of the fault-detecting algorithm. Author

N65-33952*# National Aeronautics and Space Administration, Washington, D. C.
APPLICATION OF HIGH-SPEED COMPUTERS TO THE SOLUTION OF THE RESTRICTED THREE-BODY PROBLEM BY THE HILL-BROWN METHOD. PART I: CALCULATION OF THE RIGHT-HAND SIDES OF THE EQUATIONS IN IN-HOMOGENEOUS FORM
V. A. Shor Aug. 1965 71 p refs Transl. into ENGLISH from Byul. Inst. Teor. Astron. USSR (Moscow), v. 7, no. 8, 1960 p 639–675
(NASA-TT-F-9490) CFSTI: HC $3.00/MF $0.75 CSCL 09B

The use of high-speed electronic computers is investigated for solving the restricted three-body problem by the Hill-Brown method. The logic diagram is given for a routine to compute terms on the right-hand sides of the inhomogeneous equations generated by the derivatives of the perturbation function. The same program is used to compute the terms produced by series expansion of $u\zeta^{-1}/r^3$, $z\sqrt{-1}/r^3$. Author

N65-33988# New York Univ., N. Y. Lab. for Electroscience Research.
COMPUTER STORAGE AND ANALYSIS OF CONTOUR MAP DATA Technical Report No. 400-106
S. P. Morse Feb. 1965 69 p refs
(Grant AF-AFOSR-24-65)
(AFOSR-65-0592; AD-617955)

This report describes a method for storing and analyzing contour map data in a digital computer. The data is stored in the so-called contour-line-storage form. This form represents the contour lines in terms of sequences of octally encoded, short, straight-line segments. Algorithms can be developed to analyze the data directly in this form. In some cases, however, it may be advantageous first to convert the data into a form more suitable for the particular analysis. In this report, algorithms are described for locating the ground profile of a given path on a map, generating the gradient at a point on the map, and finding the volume between two elevations. As an illustration, some of the algorithms are applied to the problem of locating the ground track of an aircraft from the pilot's record of heading and altitude vs. time. This problem involves selecting certain ground tracks as "likely candidates," generating the ground profile for each of these tracks, comparing these ground profiles with the pilot's record of altitude vs. time, and then selecting the "candidate" that most closely agrees with the pilot's record. Author

N65-34127# Naval School of Aviation Medicine, Pensacola, Fla.
CORRELATIONAL ANALYSIS OF QUALITATIVE DATA
Norman E. Lane 10 May 1965 10 p refs
(NSAM-925; AD-620023)

The development of computers has made possible the analysis of the complex interrelationships of relatively large numbers of variables. In order to use regression or multiple correlation techniques, the data from these variables must be meaningfully quantified. The raw data in medical and biological studies, however, are often expressed as categories (such as diagnoses) or in purely qualitative form (such as the presence or absence of a symptom). This paper describes a method of converting such categorical or qualitative data into a series of so-called "pseudovariables," which permits their inclusion in correlational analysis and prediction studies. Examples illustrate the method as it might be applied to a study of the relationships of occupation and cholesterol level. Extensions of the technique and additional applications are suggested. Author

N65-34156# Harry Diamond Labs., Washington, D. C.
FLUID AMPLIFICATION. 15: EXPERIMENTAL FLUIDIC ANALOG COMPUTATION
Gary L. Roffman and Silas Katz 10 Jun. 1965 54 p refs
(HDL-TR-1292; AD-619866)

The jet deflection type proportional fluid amplifier and passive fluid components have been placed in circuits to perform integration and summing. The circuits were then interconnected to solve a second-order differential equation. Solutions were obtained for both damped and undamped cases. The results vary 2 to 17 percent from the predicted values. Reasons for the discrepancies are discussed. Author

N65-34225*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
DIGITAL DATA PROCESSOR: PFM SEXADECIMAL-TO-DECIMAL CONVERTER
Gary W. Nooger and Earl C. Gernert Aug. 1965 60 p refs
(NASA-TM-X-55290; X-544-65-298) CFSTI: HC $3.00/MF $0.50 CSCL 09B

Operational and maintenance instructions are provided for a Digital Data Processor, Pulse Frequency Modulation (PFM) Sexadecimal-to-Decimal Converter. The processor has been designed to have maximum flexibility and for use in the development of PFM encoders for satellites. This processor, or special-purpose decoder, transforms the coded PFM signal into a digital printout for ease in interpretation; the inputs of the processor are directly hooked up to the satellite's encoding system. Noise and synchronization problems are, therefore, minimized. Technical specifications of the processor are given, system inputs and outputs are described, and a system block diagram is discussed. The various subsystems described include signal conditioning, digital filter, sexadecimal level selector, accumulating/shift register, binary-to-binary coded decimal convertor, time control generator, mode of operation selector, simulator, digital display, printer, and power panel. Also considered are operating controls, indicators, and programmable pinboard; maintenance and checkout; logic and circuit, card location, and interconnection diagrams. M.W.R.

N65-34239*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
A COMPUTER PROGRAM TO IMPROVE STADAN STATION SCHEDULING
Walter D. Davis Jul. 1965 48 p
(NASA-TM-X-55291; X-521-65-341) CFSTI: HC $2.00/MF $0.50 CSCL 09B

As a first step toward automatic STADAN station scheduling, a computer program is written to: (1) relieve the STADAN station scheduler from sifting through volumes of predicted satellite operations (i.e., Operational Predictions for Satellites) data to obtain the data necessary for station scheduling; (2) save the STADAN station scheduler the time, labor, and perhaps human errors of transferring the scheduling data to a station scheduling sheet or chart; and (3) place the scheduling data in a format more suitable for scheduling. The computer program is described in sufficient detail to enable anyone with a minimal understanding of general computer programming to operate it. Author

N65-34261# National Cash Register Co., Dayton, Ohio. Advanced Technology Dept.
HIGH RESOLUTION RAPIDLY PROGRAMMABLE MASKING FOR FUNCTIONAL ELECTRONIC BLOCKS First Interim Technical Report, Phase II
15 Jul. 1965 47 p
(Contract AF 33(615)-1158)
(ITR-1; AD-468443)

Effort directed toward design and fabrication of a fully automated model Phase II microscribe maskmaker are establishment of tentative specifications for design and performance, system engineering design, specification of programming methods and procedures, study of the x-y platform and drive mechanism, and study of the optical system. Author

N65-34299# Naval Ordnance Lab., White Oak, Md. Chemistry Research Dept.
AN ANALOG SYSTEM FOR REDUCING ABLATION TEST DATA
David M. Caum May 1965 32 p refs
(NOLTR-65-3; AD-464207)

An analog data reduction system was devised to reduce strip chart records of the internal temperature of an ablating body to convenient graphs of effective thermal diffusivity vs. temperature. The system is a necessary adjunct to the NOL alpha-rod technique used for experimentation with ablation materials. The analog system reduces computation time and increases precision compared with manual methods and is more convenient, when using strip chart records, than digital techniques. In addition, the overall precision of the experiment does not require the accuracy of a digital computer. A schematic, a block diagram, and typical graphs comparing analog data with data obtained using a 5-point parabolic fit are presented. Minimum analog error is about 3% when simple known functions are used as inputs. Using irregular test records as inputs results in a higher error of 5 to 10%. Author

N65-34331# Westinghouse Electric Corp., Baltimore, Md. Aerospace Div.
NUMERICAL TECHNIQUES FOR ADVANCED COMPUTERS Final Report, Feb. 1964–Mar. 1965
G. Shapiro, J. S. Squire, M. L. Graham, F. M. Carroll, D. Caswood et al Griffiss AFB, N. Y., RADC, Aug. 1965 138 p refs
(Contract AF 30(602)-3313)
(RADC-TR-65-138; AD-469697)

The purpose of the research performed under this contract was to investigate numerical techniques for advanced computers. Existing numerical techniques were studied to determine if they could be efficiently implemented using new types of logic organization. Non-standard numerical techniques were developed that yielded improvements by taking advantage of new computer organizations. Author

N65-34332# Auerbach Corp., Philadelphia, Pa.
DESIGN OF RELIABILITY CENTRAL DATA MANAGEMENT SUBSYSTEM Final Report
J. Sable et al Griffiss AFB, N. Y., RADC, Jul. 1965 160 p refs
(Contract AF 30(602)-3433)
(RADC-TR-65-189, Vol. II; AD-469269)

Volume II on the design of the reliability central data management subsystem is presented. Section I contains general information and background on the development of data management systems, and summary of report conclusions. Section II provides a consolidated chart summarizing the system comparisons from which the conclusions are drawn. Section III contains a description of the objectives and design of the reliability central data management subsystem. Detailed comparisons between the reliability central data management subsystem and each of the other systems are given in Section IV. A comprehensive discussion of all comparisons and conclusions is presented in Section V. R.N.A.

N65-34409*# General Motors Corp., Indianapolis, Ind. Allison Div.
ELECTRONIC DETECTION OF WEAK SPECTRUM LINES
R. T. Schneider and R. O. Whitaker 10 Feb. 1965 26 p
(Contract NASw-922)
(NASA-CR-67140; EDR-4153) CFSTI: HC $2.00/MF $0.50 CSCL 09B

Comparison is made between two different methods for recording spectroscopic data. One uses a digital electronic system, called an enhancetron, containing a 1024 location memory capable of recognizing weak signals; the other employs an analog electronic system where the line profile is displayed on a dual-beam oscilloscope capable of recognizing weak signals. Studies indicate that both digital and analog systems are capable of detecting and reproducing weak spectrum lines as well as those lines buried in noise. Both systems compare favorably with photographic methods; however, it is concluded that improvements in electronic design of the systems will result in better performance than is presently attained with a photographic system. M.W.R.

N65-34490# Ohio State Univ. Research Foundation, Columbus.
MEASURE THEORETICAL FOUNDATIONS OF SURFACE AREA THEORY Final Report, 15 Jun. 1962–10 Jul. 1965
Tibor Rado 2 Aug. 1965 67 p refs *Its* Rept.-1437-7
(Grant DA-ARO(D)-31-124-G312)
(AROD-1685-24; AD-620038)

A mathematically adequate basis is given for a primal algorithm to solve a special category of integer linear programming problems. The basis is the resolvent sequence which leaves great latitude for implementing the algorithm on a computer. One such specific algorithm utilizes the dual problem in the process of obtaining a resolvent sequence and, hence, an optimal contestant. Furthermore, the specific strategies used in the algorithm aim to obtain intermediate contestants which closely approximate the optimum, and aim to obtain lower bounds close to the optimum which gives a specific significance to how good an approximation is in regard to the best. Author

N65-34549# Auerbach Corp., Philadelphia, Pa.
DESIGN OF RELIABILITY CENTRAL DATA MANAGEMENT SUBSYSTEM Final Report, 5 May 1964–26 Apr. 1965
J. Sable, M. Dodge, P. J. Dixon, and T. Raday Griffiss AFB, N. Y., RADC, Jul. 1965 388 p refs *Its* Rept.-1193-TR-3
(Contract AF 30(602)-3433)
(RADC-TR-65-189, Vol. I; AD-620025)

This report describes the initial design of an automatic data processing system for Reliability Central referred to as the Reliability Central Data Management System (RCDMS). The design was accomplished as a 12 month effort ending May 1965. Volume I contains a description of RCDMS including all major operational requirements, operational functions, and design aspects, although some are only initial descriptions. The detailing of the design elements are scheduled to be carried out in a subsequent effort. In Volume II, RCDMS is compared with other major data management systems which represent current state of

data processing and information storage and retrieval systems. Some of these examined are LUCID, COLINGO and ADAM. Author

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N65-33676# Fairchild Camera and Instrument Corp., Syosset, N. Y. Systems Management and Engineering Dept.
DESIGN AND DEVELOPMENT OF A DISTANCE MEASURING DEVICE Monthly Progress Report, 1–28 Feb. 1965
E. Brown [1965] 19 p
(Contract DA-28-017-AMC-975)
(MPR-11; AD-469209)

Procedures and results are given for tests conducted on printed wiring boards. The following circuit assemblies were bench tested with satisfactory results: electronic counter, regenerative comparator, comparator, electronic switch, velocity window sensor and logic gate, first integrator, and second integrator. C.T.C.

N65-33688# New York Univ., N. Y. Research Div.
A SURVEY OF COMMERCIAL AND MILITARY BRIDGES
Jun. 1964 65 p
(Contract NObsr-89288)
(SETE-210/77; AD-460896)

A compilation is presented of all military and commercial bridges and bridge-type instruments. All instrumentation utilizing the bridge balancing principle are included and two distinct groups are classified for both types of bridges: (1) units whose basic function is to measure specific component values such as resistance, capacitance, or inductance; and (2) units which measure unusual characteristics such as SWR, strain, or cryogenic temperatures. A short summary includes descriptions of the following bridges: Wheatstone, Mueller, Kelvin, limit, impedance, transformer ratio arm, Varley and Murray loops, Maxwell and Hay circuits, summation, and Wenner. Also included in the report are temperature, power, impedance, high frequency, strain gauge, synchro and resolver, Hartshorn, Jones, and Hoopes bridges. The parameter and range along with other data are given for each of the bridges in the compilation. M.W.R.

N65-33697# Datametrics Corp., North Hollywood, Calif.
RESEARCH AND DEVELOPMENT OF UNPOWERED PERSONAL TRANSMITTER TECHNIQUES Research Contract Status Report No. 55, 1 Mar.–1 Apr. 1965
7 Apr. 1965 8 p
(Contract AF 33(615)-2206)
(AD-465191)

A breadboard receiver is discussed in terms of receiver sensitivity, power supply source, and selectivity. In the design presented, a single transistor audio stage replaces the two transistor audio stage. The new design has the features of the two transistor audio stage, in addition to two advantages: the substitution of a TIXMO1 transistor to replace the former 2N1308 and 2N1309 transistors, yielding an eight transistor receiver which uses only two types of transistors; and the elimination of the need for a +9 v battery. The receiver uses a current-saving type of sensitivity control, and a crystal frequency of 9000 kc. A schematic of the breadboard receiver and companion transmitter is included, in addition to preliminary measurements of the receiver characteristics. G.A.L.

N65-33760# General Electric Co., Auburn, N. Y. Semiconductor Products Dept.
A PRODUCT ENGINEERING MEASURE FOR THE IMPROVEMENT OF PRODUCTION TECHNIQUES TO INCREASE THE RELIABILITY AND TO IMPROVE PRODUCT CAPABILITY OF HIGH VOLTAGE MINIATURE SILICON RECTIFIERS, TYPE IN4249 Quarterly Progress Report, 30 Dec. 1964–31 Mar. 1965
W. R. Comstock, N. E. Devolder, R. R. Schall, and E. G. Tefft [1965] 84 p
(Contract DA-36-039-AMC-06157(E))
(QPR-1; AD-619258)

The first quarterly progress report of a Product Engineering Measure (PEM) for the improvement of production techniques to increase the reliability and improve the product capability of high voltage miniature silicon rectifier, of the IN4249 type, under the USAECOM Contract No. DA-36-039-AMC-06157 (E) of 30 December 1964, covers the work performed on the pellet design, reliability test equipment, the glass casting process and the rating requirements of leaded rectifiers. A PERT analysis depicts the progress of this program and provides certain conclusions regarding the work performed to date. Author

N65-33773# New York Univ., N. Y. Electron Tube Group.
PROJECTS DEALING WITH ADVANCED ELECTRON DEVICE TECHNOLOGY Status Report
Feb. 1965 49 p refs
(Contract DA-28-043-AMC-00039(E))
(SR-85; AD-463584)

Advanced electron device technology is considered in summaries of government-sponsored projects and some related abstracts from non-government publications. Projects are divided into three general categories: development, evaluation, and production; device rating, reliability, life, and environmental studies; and device techniques and studies of related phenomena. Low and high power, microwave, passive, and special devices are discussed. Three projects dealing with optical masers are summarized. M.W.R.

N65-33857*# Stanford Research Inst., Menlo Park, Calif.
THE DESIGN OF AN EXPERIMENT TO DETERMINE THE LIMITATIONS IMPOSED ON A MULTIPLE-APERTURE ANTENNA SYSTEM BY PROPAGATION PHENOMENA Final Report
Charles H. Dawson, ed. Jun. 1965 263 p refs
(Contract NAS5-3974)
(NASA-CR-67010) CFSTI: HC $6.00/MF $1.25 CSCL 09F

The design of experiments to determine the effects of propagation phenomena on the operation of a multi-aperture antenna array and to relate these effects to the states of the troposphere and ionosphere were examined. Both partial and complete programs of meteorological and ionospheric data acquisiton are described; data collection and processing is outlined; and expected accuracies are estimated. The following instrumentation was recommended: (1) a satellite in a 10-hour-period polar orbit capable of transmitting at 2, 4, 8, and 16 Gc with a minimum power of one watt; (2) two or more antennas with diameters of four meters or more, with monopulse feeds, and antenna-mounted preamplifiers; (3) two or more three-channel receivers; (4) data conversing

and multiplexing equipment with a tape recorder capable of 40 kilobits per second; (5) conventional meteorological instruments; and (6) a magnetometer to measure variations in the earth's magnetic field. Experiments on phase and angle-of-arrival fluctuations were found to be of primary importance to the design of the multiple-aperture array. G.G.

N65-33888# Microwave Associates, Inc., Burlington, Mass.
THE FABRICATION AND CHARACTERIZATION OF SCHOTTKY FOR S, X AND KU BAND Quarterly Report, 1 May–1 Aug. 1965
Charles M. Howell and Carmen Genzabella [1965] 33 p
(Contract AF 33(615)-2741)
(QR-1; AD-470917)

"Bilithic" Schottky barrier diodes are being fabricated for use in S, X, and Ku bands. The diodes are being packaged in standard cartridges, coaxial packages and in glass packages for stripline use. Noise figures of 6.5 db have been obtained in S band and 8.0 db in X band. The video spike burnouts are 5–10 ergs and the c–w burnout power appears to be well in excess of 250 mw. Design studies of an integrated circuit balance mixer indicate that conductor losses are a major problem. Author

N65-33891# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
OPTICAL PROPERTIES OF CdSe AND ZnO SINGLE CRYSTALS
John Sherman De Witt (M.S. Thesis) May 1965 103 p refs
(SP/PH/65-8; AD-617923)

The optical properties of CdSe and ZnO single crystals have been determined from reflectivity measurements in the range of photon energies 2.5–14 electron volts. The measurements were made in a one meter vacuum monochromator using a hydrogen emission source. The crystals were grown from the vapor phase and consisted of platelets (CdSe) and bulk prisms (ZnO). The optical constants, n and k, and the real and imaginary parts of the dielectric constant were derived from the reflectivity measurements by a Kramers–Kronig analysis. The observed spectrum of CdSe is in good agreement with previously reported results of Cardona. The observed ZnO spectrum corresponds with similar results reported for other II–VI wurtzite semiconductors. The peaks have been interpreted as direct interband transitions in terms of an analogous zinc-blende energy band structure. Author

N65-33936# Commissariat a l'Energie Atomique, Sacalay (France). Centre d'Etudes Nucléaires.
RESISTIVITY MEASUREMENTS USING A DIRECT CURRENT INDUCTION METHOD [MESURE DE RESISTIVITE PAR LA METHODE D'INDUCTION EN COURANT CONTINU]
Jean Delaplace and Jacques Hillairet 1964 35 p refs In FRENCH; ENGLISH summary
(CEA-R-2402) CFSTI: HC $2.00/MF $0.50

The conventional methods for measuring electrical resistivities necessitate the fixing of electrical contacts on the sample, either mechanically or by soldering. Furthermore, it is also necessary to carry out the measurements on low cross section samples which are not always easy to obtain. The direct current induction method, on the other hand, requires no contacts and can easily be applied to samples of large cross section. The sample is placed in a uniform magnetic field; at the moment when the current is cut, eddy currents appear in the sample which tend to oppose the disappearance of the field. The way in which the magnetic flux decreases in the sample makes it possible to determine the resistivity of the material. In the case of metals which are good conductors, this method was applied to samples having diameters between 1 and 30 mm. It gives a value for the local resistivity and makes it possible to detect any variation along the sample. The measurements can be carried out at all temperatures, from a few degrees absolute to 500° C. This method constitutes an interesting means of investigating the resistivity of solid materials. Its accuracy and rapidity make it particularly adapted both to fundamental research and to production control. Author

N65-33943# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).
THE THREE-STAGE SYSTEM. A CIRCUIT FOR THE APPLICATION OF TERNARY ALGEBRA [IL TRISTABILE: UN CIRCUITO PER L'APPLICAZIONE DELL' ALGEBRA TERNARIA]
B. Bertolucci 16 Jun. 1965 18 p refs In ITALIAN *Its* Nota Interna No. 279
(LNF-65/18) CFSTI: HC $1.00/MF $0.50

A tri-stable stage computer circuit, using a ternary algebraic code, is described. The circuit, whose stages are in cyclic sequence, is a combination of a flip-flot device and a tri-stable computation scale. Circuit design diagrams are included, in addition to a discussion and calculations of the minimum number of components which can constitute a demultiplication system. Transl. by G.A.L.

N65-33969*# Melpar, Inc., Falls Church, Va.
THIN-FILM PERSONAL COMMUNICATIONS AND TELEMETRY SYSTEM (TFPCTS) First Quarterly Report, 21 Dec. 1964–21 Mar. 1965
Apr. 1965 91 p refs
(Contract NAS9-3924)
(NASA-CR-65147) CFSTI: HC $3.00/MF $0.75 CSCL 09A

Investigations are being conducted in the areas of high frequency thin film triodes, magnetic permeability films, metal base transistor devices, inductors, dielectrics, and high frequency substrates. Masks were designed and formed and a dual vacuum was built for the thin film triodes; and source-drain spacings of 2.5 microns were achieved with tungsten wire of the same size. Transconductance values to 5000 μ mhos and power capabilities of more than 100 MW are obtained with CdSe devices; transconductance values of CdS and CdS-CdSe mixtures are low. Thin film structures, suitable for both emitter and collector junctions, were fabricated by vacuum depositing of both Zn and CdSe using gold electrodes. No junction failures are reported under shelf-life conditions; the junctions are unprotected and stored at room temperature and atmosphere. It is possible to vary the potential barrier height between the gold plate and the semiconductor and to position this barrier with respect to the electrodes. M.W.R.

N65-34015# Bliley Electric Co., Erie, Pa.
PRODUCTION ENGINEERING MEASURE, CR-(XM-53)/U QUARTZ CRYSTAL UNITS Quarterly Report, Feb.–Apr. 1965
J. M. Wolfskill, Merle George, and Robert Mouck [1965] 26 p
(Contract DA-36-039-AMC-03640(E))
(QR-2; AD-618490)

This report covers the second quarterly interval of the Production Engineering Measure-Reliability study of CR-(XM-53)/U quartz crystal units. These high-Q, low-power units, mounted in HC-27 glass holders, cover the 1-Mc to 5-Mc frequency range. During this period, accurate measurements of effective resistance were attained the 2-microwatt drive level by making minor modifications to the TS-330(AGC) test set to permit it to function as a "Transmission

line" circuit. These more accurate measurements disclosed that there were problems in meeting the 10^6 Q at the 5-Mc level as well as at the 1-Mc level, where several mounting arrangements had been evaluated without success. The various mounting arrangements are described, as well as the current approaches which involve attainment of higher Q levels by the quartz resonators themselves, rather than complete dependence on the mounting arrangements. Author

N65-34042# HP Associates, Palo Alto, Calif.
HOT ELECTRON AMPLIFIER Interim Engineering Report, 1 Oct.–31 Dec. 1964
[1964] 24 p
(Contract AF 33(615)-2035)
(IER-2; AD-463702)

The deposition of silicon at temperatures below 1000° C by the vapor phase $SiCl_2$ reaction is described. This method gives epitaxial deposits of Si on Si as low as 900° C; this Si is sufficiently perfect to make ideal Schottky barrier diodes. The process is now being optimized for deposition of Si on molybdenum. The vapor deposition of Mo on Si by a variety of new methods is also described. The best results still are achieved by hydrogen reduction of $MoCl_5$. The problem of an intervening oxide layer has been solved; ideal Schottky barrier diodes can now be made with Mo deposited on Si at 700° C. Some Mo–Si samples have been heated in vacuum as high as 900° C for 10 minutes with negligible degradation of the diode characteristics. Some Si-Mo-Si structures have been made and are now being evaluated. Author

N65-34045# Varian Associates, Palo Alto, Calif.
HETEROJUNCTION DEVICE CONCEPTS Interim Engineering Report, 1 Feb.–25 Apr. 1965
H. Kroemer and G. Day Wright-Patterson AFB, Ohio, AF Avionics Lab., May 1965 23 p refs
(Contract AF 33(615)-1988)
(IER-3; AD-464835)

The object of this contract is the generation and invention of novel electronic device concepts, based on heterojunctions. A more detailed theoretical study of the proposed ZnSe-Ge Auger junction was initiated. A current amplification factor increasing with increasing current seems possible, making various switching devices appear achievable. Experimentally, high-resistivity epitaxial growth of ZnSe on Ge was achieved, and heterojunction diodes with promising electrical properties were obtained. The VLS approach to heterojunctions was discontinued because it encountered severe obstacles due to balling-up of the liquid metal. The work on NC diode electrodes was transferred to another contract. Author

N65-34061# Microwave Electronics Corp., Palo Alto, Calif.
MEDIUM-POWER, LOW-NOISE TUBE DEVELOPMENT, PHASE II Interim Development Report, 1 Sep.–30 Nov. 1963
Sep. 1964 13 p
(Contract Nonr-3470(00)(X))
(IDR-11; AD-614469)

The prototype design of the vacuum envelope and the PPM package unit was completed. Ten vacuum envelopes have been built and tested. Operation of the tube was brought to within 1 db of the required 2-watt gain compression specification of 1 db. A backward wave oscillation prevents beam currents in excess of 18 milliamperes thereby limiting this gain compression. One tube, using vacuum envelope 40, was put through temperature and vibration environments. Author

N65-34063# Microwave Electronics Corp., Palo Alto, Calif.
MEDIUM-POWER, LOW-NOISE TUBE DEVELOPMENT, PHASE II Interim Development Report, 1 Dec. 1963–28 Feb. 1964
Sep. 1964 15 p
(Contract Nonr-3470(00)(X))
(IDR-12; AD-614470)

Ten tubes were tested in connection with a program to develop medium power, low noise, traveling wave tubes. The tubes allowed low noise (22db) operation at one db gain compression and at one watt output. Beam current level of these tubes was 18 ma; and an attempt to raise beam current to provide a one db maximum gain compression at the two-watt level was unsuccessful because the tube developed a spurious backward oscillation. A number of experiments involving velocity tapering and beam expansion in the output helix did not curb this oscillation. The problem was solved, however, by raising the beam current level to 20 ma by splitting the helix into three cascade sections; and by creating a helix structure with two attenuator sections located at one-third and two-thirds the distance along the helix from the input coupler. The two attenuator points were built into a vacuum envelope which gave stable gain, noise figure, and power-out performance at various temperatures. M.W.R.

N65-34069# Inter-Range Missile Flight Safety Group, White Sands Missile Range, N. Mex.
FLIGHT TERMINATION RECEIVER CATALOG
Sep. 1964 120 p refs
(IRMFSG-306-64; AD-461407)

A catalog of flight termination receivers accepted for use at U.S. Missile Testing Ranges is presented. A general description, performance data, and manufacturers specifications are included for each of the receivers. G.A.L.

N65-34070# Whittaker Corp., Chatsworth, Calif. Controls and Guidance Div.
SINGLE PLANE CONTROL SYSTEM FOR THE NIKE-JAVELIN Final Report
R. T. Martin Eglin AFB, Fla., Air Proving Ground Center, May 1965 73 p
(Contract AF 08(635)-3771)
(APGC-TR-65-43; AD-467032)

This report is a description of the roll stabilized single plane Attitude Control Unit developed for the Air Proving Ground Center. The report contains a summary of the ground testing program and a simulation computer program for the Attitude Control. The Attitude Control Unit was developed for the Nike-Javelin space probe to be used in Project Trump. Author

N65-34072# New York Univ., N. Y. Electron Tube Group.
PROJECTS DEALING WITH ADVANCED ELECTRON DEVICE TECHNOLOGY
Dec. 1964 52 p
(Contract DA-28-043-AMC-00039(E))
(SR-84; AD-463583)

Brief summaries are presented on the results being achieved by government agencies in the field of advanced electron device technology. Microwave, low power, high power, and passive devices, special devices, and optical masers are considered in terms of production evaluation, reliability and device techniques. G.A.L.

N65-34092# Stanford Research Inst., Menlo Park, Calif.
RELIABLE DIELECTRIC FILMS FOR MICROCIRCUITS Final Report, 1 Apr. 1964–31 Mar. 1965

Saul W. Chaikin and Gilbert A. St. John May 1965 66 p refs (Contract DA-36-039-AMC-02204(E))
(AD-617958)

By means of electron microscope study techniques, important properties of aluminum electrode edges were determined. Premature capacitor breakdown at edges is most likely caused by a 3 to 5 fold field enhancement at the edge. Such a razor edge will give rise to field enhancement such that the edges can be at breakdown voltage while the planar portion of the capacitor is not. It was found that electrical leakage of SiO capacitors is enormously sensitive to deposition rate and somewhat sensitive to thickness; and that deposition rate and thickness interact in their effect on leakage. Life tests of SiO capacitors of 1000 Å and 10,000 Å dielectric thicknesses at 85° C and 10,000 Å thickness at 125° C were successful showing that fabrication procedures developed in a predecessor contract represented an improvement over existing procedures. Author

N65-34094 Naval Ordnance Lab., Corona, Calif. Electricity and Magnetism Div.
CODER COMPONENTS PROGRAM. MAGNETIC FILM PARAMETRON CODERS
R. L. King and J. H. Joanson *In its* Foundational Res. Proj. 1 Jun. 1965 p 1–8 refs (See N65-34093 22-34)

It is shown that the thin magnetic film parametron can be used successfully as a digital component in code generators. One of the simplest code generators consists of a single storage element and a logic element that changes one to zero and vice versa, and then feeds the inverted signal back to the storage element. Since the parametron operates with a three-phase clock signal, three parametron elements are required for each storage element. The difference between a one and a zero is in the phase of the resonant signal; therefore, the not circuit is accomplished simply by changing or reversing the polarity of the coupling between two parametrons. A double ring experiment is described and indicates that a more sophisticated coder could be constructed. Circuit schematics are included for a parametron and a parametron ring. C.T.C.

N65-34099 Naval Ordnance Lab., Corona, Calif. Electronics Div.
SMALL ANTENNA STUDY. MULTIPLE CONDUCTOR VLF DIPOLE
E. W. Seeley, I. Rainwater, and D. A. Wulfing *In its* Foundational Res. Proj. 1 Jun. 1965 p 47–58 refs (See N65-34093 22-34)

An antenna experiment was conducted to find methods of radiating VLF energy efficiently over a broad frequency band by means of simple, easily built structures. A brief theoretical background is given using equations for the vertically polarized field in the horizontal plane from a horizontal conductor. A multiple conductor dipole antenna 2 km long was laid out on the ground, and radiation field measurements were made at a distance of 109 km. Various other measurements were also made, such as input impedance, characteristic impedance, loss, soil conductivity, and current distribution. The radiation field measurements were made on a 2 and a 10 conductor dipole with both sinusoidal and uniform current distribution. The purpose of these were to confirm the theoretical formulas for field strength, efficiency, and radiated power. The experimental and theoretical comparisons are given in tabular form. Both the 2 and the 10 conductor dipoles with sinusoidal current distribution were far less efficient than theory would predict. However, in comparing their radiated fields it is seen that using multiple conductors greatly increases the efficiency. C.T.C.

N65-34138# Philco Corp., Lansdale, Pa. Microelectronics Operation.
THIN FILM ACCELERATED LIFE TESTS Technical Report, 10 Feb. 1964–10 Feb. 1965
M. J. Walker and M. Sharp Griffiss AFB, N. Y., RADC, Jun. 1965 160 p refs
(Contract AF 30(602)-3287)
(RADC-TR-65-137; AD-619689)

The purpose of the program is to study, investigate, and develop test and measurement techniques for controllably accelerating the aging processes in tantalum thin film R-C networks, and to study and investigate the physics of failure associated with the R-C networks. The initial phase of the program included a review of related literature, the construction of individual tantalum thin film resistors and capacitors, accelerated testing of these structures, and failure mechanism determination. A number of failure modes were determined as a result of testing and analysis of the individual resistors and capacitors. There are indications that three basic failure mechanisms are related to all failures and are the failure rate controlling mechanisms; they are: (1) oxidation; (2) ion migration; and (3) crystallization (both field-induced and temperature induced). Some rate information was determined on the oxidation mechanism. Author

N65-34139# Westinghouse Electric Corp., Yorkville, N. Y.
SOLID STATE SWITCH STUDY Final Report
T. C. New, T. P. Nowalk, H. E. Ferree, T. Hamburger, R. Smith et al Griffiss AFB, N. Y., RADC, Jun. 1965 148 p
(Contract AF 30(602)-3296)
(RADC-TR-65-119; AD-619462)

To achieve solid state switch capability beyond the state of the art, new concepts in design, encapsulation evaluation, and circuitry of silicon controlled rectifiers were studied. A flat disc-shaped encapsulation was developed which is adaptable to series stacking and reduced space requirements. Triggering methods of the series configurations of thyristors were studied. An optical-electrical triggering technique was developed and feasibility demonstrated. The circuit utilizes a xenon light source and a light sensitive switch coupled by fibre optic lightguides. A breadboard modulator using these techniques was fabricated and tested sucessfully. A series stack of six flat packaged thyristors was evaluated as the power switch in the modulator and results were excellent. Author

N65-34149# Army Electronics Labs., Fort Monmouth, N. J.
AUTOMATIC ELECTRONIC FOUR-WIRE SWITCHING SYSTEM FOR THE FIELD ARMY
Leo H. Wagner Mar. 1965 33 p
(ECOM-2590; AD-619730)

This report describes the automatic electronic four-wire switching system for the Field Army. The equipment description lists all equipment items and provides a brief outline of their characteristics. The signaling and supervision section describes the in-band multi-frequency compound tones and some typical signaling sequences. The numbering plan describes the seven digit number capability, including abbreviated dialing. Systems employment indicates a type employment possible with this system. Author

N65-34150# General Electric Co., Schenectady, N. Y. Advanced Technology Labs.
GASEOUS DISCHARGE SWITCH IN OVERSIZED WAVEGUIDE
John P. Quine, Cousby Younger, and Lewi Tonks Griffiss AFB, N. Y., RADC, Jul. 1965 53 p refs
(Contract AF 30(602)-3544)
(RADC-TR-65-145; AD-619690)

This report presents the progress that has been made in a theoretical and experimental investigation of dc triggered spark gap switches for oversized rectangular waveguides. These switches which operate at atmospheric pressure employ a symmetrical arrangement of several spherical spark gaps in order to prevent the generation of higher order propagating modes. The results of a theoretical study of low pressure gaseous electronic switches is also presented which indicate that a Penning type discharge may have important advantages. Author

N65-34157# Army Electronics Lab., Fort Monmouth, N. J.
PPI VIDICON SIGNAL GENERATOR
Philip F. Krzyzkowski Jul. 1965 11 p
Jul. 1965 11 p
(ECOM-2599; AD-619457)

Synthetic PPI scanned information is generated by radial scanning of a vidicon exposed to an image from an optical slide projector. This is actually a flying-spot-scanner scanned radially instead of in a raster mode. The output signal may be displayed on a long-persistence display device scanned in the PPI mode. The circuitry and operation of the experimental setup are discussed. Author

N65-34159# Collins Radio Co., Newport Beach, Calif.
FILTER CRYSTAL DEVELOPMENT PROGRAM (70 TO 150 MC) Quarterly Progress Report No. 6, 15 Oct. 1964–14 Jan. 1965
R. A. Auriemma 16 Feb. 1965 18 p
(Contract DA-36-039-AMC-03207(E))
(Rept.-523-1000706-00152F; AD-619710)

Data has been gathered on plateback versus electrode thickness for 90 Mc, third overtone crystal units with 1.1 mm, 0.8 mm, and 0.6 mm diameter electrodes. This involved a method of measuring the unplated resonant frequency of the quartz blanks and the resonant frequency of a plated but unmounted blank. Subsequent measurements on plated mounted blanks have shown that measurement of the resonant frequency of plated blanks before mounting is necessary for good technique in the case of thin electrode plating or small values of plateback. Author

N65-34162# Weston Instruments, Inc., Newark, N. J.
A POROUS SUBSTRATE RESISTOR AIMED AT MINIATURIZATION OF METAL-FILM RESISTORS Interim Development Report, 1 Dec. 1964–28 Feb. 1965
T. Matley and R. E. Busch [1965] 39 p
(Contract NObsr-87542)
(IDR-10; AD-619824)

A correlation between structural characteristics of the substrate and reproducibility of resistance values is illustrated. It is advocated that the quality of the substrate can be typified by the standard deviation in weight-to-volume ratio and the standard deviation in flow. These two parameters have been combined to give a quantitative measure of substrate uniformity by defining a structure factor. In most cases, the average % standard deviation in resistance is linearly proportional to the structure factor. In obtaining this correlation, it is necessary to consider groups defined by substrate type and method of terminating. It is thus a statistical result which cannot be applied to individual units or metallizing lots. Author

N65-34163# Army Electronics Labs., Fort Monmouth, N. J.
HIGH-VOLTAGE, ITERATIVE-GRID THYRATRONS
Sol Schneider and John E. Creedon Jun. 1965 25 p refs
(ECOM-2594; AD-619571)

Thyratrons are designed to operate in the low pd (pressure times distance) region of the Paschen characteristics of the gas in order to achieve high-voltage operation. In hydrogen thyratrons (the most widely used modulator device operating in this pressure region), reliable operation with a single high-voltage gap is limited to about 35 kilovolts. The minimum pressure and the interelectrode spacing are limited by the need to maintain adequate density for conduction of high current and effective cooling of the electrode (particulary during commutation), and by field-emission breakdown. In order to obtain high-voltage operation, it is necessary to divide the voltage over many gaps by the addition of gradient grids. A design for iterative grids has been evolved that permits unlimited stacking to provide operation at any voltage level desired. Basic design considerations and the experimental procedure and facility are discussed. Author

N65-34164# General Telephone and Electronics Labs., Inc., Bayside, N. Y.
SEMICONDUCTOR MICROWAVE AMPLITUDE AND PHASE MODULATOR Quarterly Report No. 8, Feb. 16–May 15, 1965
R. Harrison, J. Zucker, F. Drago, and D. Fleri [1965] 17 p ref
(Contract DA-36-039-AMC-02284(E))
(TR-65-103.8; AD-619579)

Experiments on the amplitude modulator indicate a linear falloff of modulation depth with drive frequency from 12.5 percent at 0.9 Gc/s to 8.4 percent at 1.4 Gc/s. It appears from these data that the useful modulation bandwidth of this device in its present configuration falls in the 1 Gc/s range. The drive power required to maintain a constant modulation index as the rf carrier power was varied over a three to one range was experimentally determined. A linear relation existed between the drive and carrier power levels. Measurements indicate that the injecting point contact can be represented by a series LCR circuit in shunt with the transmission line. On the basis of this circuit, it is possible to explain the observed decrease in insertion loss with forward bias. The stability of the GaAs varactors was improved by coating the semiconductor surface with a thin film of epoxy. However, the yield was limited, and some electrical deterioration occurred immediately after application of the epoxy coating. Author

N65-34172# General Electric Co., Syracuse, N. Y. Heavy Military Electronics Dept.
PULSING AND CROSSTALK STUDIES IN SEMICONDUCTOR CIRCUITS Final Report, 15 May 1963–30 Mar. 1965
G. Burton Harrold and W. Reichel [1965] 160 p refs
(Contract DA-36-039-AMC-D2263(E))
(AD-620048)

Transistor distortion in rf amplifiers was evaluated. Additional consideration was given to parameter measurement, noise figure, AGC and transistor rf stability. A step-by-step design procedure was arrived at. The rf properties of field effect transistors were studied. TAB

N65-34179# Microwave Associates, Inc., Burlington, Mass.
HIGH POWER SEMICONDUCTOR TR DEVICES Seventh Quarterly Progress Report, 1 Jan.–31 Mar. 1965
R. H. Brunton, III [1965] 50 p
(Contract DA-36-039-AMC-03187(E))
(Rept.-7; AD-619679)

Efforts have resulted in improved performance of the X_L-band switch design. The improvements through electrical and mechanical changes in the switch design resulted in greater operational bandwidth and improved diode mounting. The Ku-band work on evaluation of limiter diodes has been continued. Performance data of diodes is given in this report. New Ku-band diode mounts have also been evaluated and show improvements in overall performance. Author

N65-34180# Army Electronics Labs., Forth Monmouth, N. J.
SECULAR STABILITY OF MILITARY-TYPE, LOW-FREQUENCY QUARTZ CRYSTAL UNITS
Patrick E. Mulvihill Apr. 1965 29 p refs
(ECOM-2591; AD-619509)

This report summarizes the aging data obtained on several military-type quartz crystal units in the frequency range 80.0 kc/s to 500.0 kc/s. The resonator plates of these units are NT-, DT-, CT- and 5° X cuts of quartz. Aging data is presented in frequency variation versus time graphs and scatter diagrams. Author

N65-34219*# Hamilton Standard Div., United Aircraft Corp., Broad Brook, Conn.
NONDISSIPATIVE DC TO DC REGULATOR-CONVERTER STUDY Third Quarterly Report, 15 Dec. 1964–15 Aug. 1965
Frank L. Raposa [1965] 61 p refs
(Contract NAS5-3921)
(NASA-CR-67038; HSER-3124) CFSTI: HC $3.00/MF $0.75
CSCL 09A

Continued research conducted under a program designed to develop concepts, techniques, and modular circuitry for nondissipative dc to dc converters in the power range of 0- to 100-watts, is reported. Major efforts focused on: (1) initial breadboard development of the self-stabilizing chopper power stage, (2) evaluating several frequency control stages, (3) testing and evaluating the frequency-efficiency characteristics of the self-stabilizing chopper, and (4) size and weight analysis of the self-stabilizing chopper. Solutions to inherent problems associated with circuit starting, circuit recovery time, and balanced operation, were determined. Breadboard studies of several variable frequency sources were made to determine the most applicable frequency source. Considered were the following circuits: the unijunction transistor relaxation oscillator, the astable multivibrator oscillator, and the saturating core square wave oscillator. The frequency-efficiency characteristics of the self-stabilizing chopper regulator were obtained. A size and weight analysis of the regulator was obtained for nominal switching frequencies of 5, 10, 20, and 30-KC. Results of these analyses were used to determine the optimum switching frequency for the chopper regulator. S.C.W.

N65-34257# Massachusetts Inst. of Tech., Cambridge. Instrumentation Lab.
A METHOD FOR ELECTROSTATIC POWER TRANSFER OF WHEEL-MOTOR POWER THROUGH GYROSCOPE DAMPING FLUID
Howard Musoff Mar. 1965 30 p refs
(Contracts AF 33(657)-7668; AF 33(615)-2243)
(E-1753; AD-467986)

A method is described whereby two half-cycle cosine-modulated radio-frequency carrier waves are used to transfer gyroscope wheel-motor power through the gyroscope damping fluid. This half-cycle modulation method is compared with both full-cycle amplitude modulation and suppressed-carrier modulation methods for transferring power. Also presented are efficiency measurements obtained from a breadboard demodulator using the half-cycle modulation method. Author

N65-34263# Microwave Electronics Corp., Palo Alto, Calif.
ONE-WATT CW S-BAND TRAVELING-WAVE TUBE WITH 6-DB NOISE FIGURE
Normal Berger Griffiss AFB, N. Y., RADC, Aug. 1965 21 p
(Contract AF 30(602)-3025)
(RADC-TR-65-240; AD-469647)

Use of Cathaloy A-33 has been discontinued for cathodes giving long-life, high-current-density operation. Consistently good minimum noise figures were obtained narrowband, but broadband noise figures were generally high. The larger diameter gun has inherent fabrication difficulties. Author

N65-34336# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.
[EXTENSION OF THE USEFUL FREQUENCY SPECTRUM INTO THE RANGE FROM MICROWAVE FREQUENCIES TO OPTICAL FREQUENCIES AND IMPROVEMENT OF EXISTING DEVICES AND TECHNIQUES IN THE MICROWAVE SPECTRUM] Quarterly Report, Apr. 1–Jun. 30, 1965
L. Goodrich et al 30 Jun. 1965 62 p refs
(Contracts Nonr-1288(05); AF 33(657)-8677; DA-36-039-AMC-02372(E); Grant NSF GK-29)
(MDL-Q13; AD-468753)

Parallel studies of electron beam devices, solid-state devices, and plasmas, which focus on achieving the overall program objectives, are reported. S.C.W.

N65-34338# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
INVESTIGATION IN THE FABRICATION OF SILICON CARBIDE 500°C RECTIFIER Interim Engineering Report, Apr. 1-Jun. 30, 1965
H. C. Chang [1965] 71 p refs
(Contract AF 33(615)-2363)
(IER-2; AD-464985)

Continued research focusing on the development of high temperature, high power solid-state devices from wide band gap semiconductors, such as silicon carbide, for use in advanced supersonic aircraft and aerospace electrical applications, is reported. In connection with a study aimed at the development of a 30-ampere forward current, 300-volt peak reverse voltage SiC diode capable of operating at 500° C, material preparation methods, junction formation techniques, and rectifier fabrication processes were investigated. Presented are preliminary results of these analyses and a synopsis on future areas of investigation. S.C.W.

N65-34372# McCoy Electronics Co., Mount Holly Springs, Pa.
GLASS INCLOSED CRYSTAL UNITS Final Report
[1965] 210 p
(Contract DA-36-039-SC-81-269)
(AD-617959)

Problems and solutions encountered in design fabrication and testing of the CR-(XM-17)/U crystal unit are discussed. Also included is economic information comparing cost factors of metal versus glass holder packaging. Data obtained in performing various tests on a total of 225 units is presented. Processing details for fabricating the CR-(XM-17)/U crystal unit is outlined. A quality control and inspection plan is also outlined. Identification of key personnel, man hours expended, publications and conference information is included in this report. Author

N65-34386# European Organization for Nuclear Research, Geneva (Switzerland).
THE ELECTRONIC LOGIC SYSTEM USED WITH THE MAGNETIC SPARK CHAMBER
W. Beusch 31 May 1965 17 p refs
(CERN-65-21) CFSTI: HC $1.00/MF $0.50

The main features of the electronic logic system for use with the magnetic spark chamber are described. The logical functions are performed by relatively simple plug-in units

that are dc-coupled and work on standard signal voltages. The main units of the system are: (1) a discriminator for photomultiplier pulses; (2) a fivefold coincidence unit; (3) a fan-in circuit with or without negation; (4) a fan-out; and (5) a limiter for photomultiplier pulses. Each of the units is discussed. The system allows a reasonably good time resolution with a very good plateau efficiency. The step function output of the discriminators results in the following: (1) no multiple output for long signals; (2) good anticoincidence efficiency; (3) a free choice of coincidence and anticoincidence time resolution; and (4) the possibility to use a simple trigger display system. E.E.B.

N65-34397*# Texas Instruments, Inc., Dallas. Semiconductor-Components Div.
DESIGN, DEVELOPMENT AND DELIVERY ON ONE (1) BREADBOARD MODEL AND THREE (3) PRODUCTION UNITS OF A 75 VA INTEGRATED STATIC INVERTER Technical Summary Report, 27 Apr.–27 May 1965
11 Jun. 1965 32 p ref
(Contract NAS8-11925)
(NASA-CR-67057) CFSTI: HC $2.00/MF $0.50 CSCL 09E

Progress is reported on the development of a breadboard model and three production units of a 75 VA integrated static inverter. Developments are discussed on the power supply system, circuit design, power devices, Johnson countdown counter and circuit, power transformers, dc regulator, output filter, and temperature compensated crystal oscillator. R.N.A.

N65-34416*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE ANALYSIS OF TIME MULTIPLEXING SYSTEMS FOR PARTIAL SUCCESS
Donall G. Bourke 15 Jan. 1965 28 p refs
(Contract NAS7-100)
(NASA-CR-67066; JPL-TR-32-698) CFSTI: HC $2.00/MF $0.50 CSCL 09F

This report is an attempt to improve analysis methods for time multiplexing systems under partial-success criteria. Results of the analysis are in the form of probability distribution for the number of surviving measurements in a multiplexer configuration. This form of result allows such criteria to be applied as the expected number of measurements, the expected value of the weighted measurements, or the probability that the number of surviving weighted measurements will be greater than some preassigned value. The analysis for multiplexer configuration is based upon first modeling the basic multiplexer deck. A representative solid-state deck used by the Jet Propulsion Laboratory is used as an example. After the probability distribution of surviving measurements is obtained, its general form is used to extend the analysis to general and more complex multiplexer configurations of more than one deck. Some numerical results are presented and areas for further investigations are discussed. Author

N65-34463*# Texas Instruments, Inc., Dallas. Semiconductor-Components Div.
THE STUDY OF THE EPITAXIAL PARAMETERS ON RELIABILITY OF SILICON PLANAR DEVICES Technical Summary Report, 25 Jun. 1964–25 Jun. 1965
W. M. Bullis, W. R. Runyan, and R. L. Petritz 20 Aug. 1965 134 p refs
(Contract NAS8-11330)
(NASA-CR-67158; TI-03-65-81) CFSTI: HC $4.00/MF $1.00 CSCL 09A

The effect of epitaxial parameters on the reliability of silicon planar devices was investigated. The properties of the silicon substrates, substrate surface preparation, and growth conditions for the epitaxial layers were varied. High reliability, n-p-n, double-diffused, epitaxial planar silicon transistors were fabricated from layers deposited under different conditions. Power step-stress tests, temperature only step-stress tests, high temperature storage tests, and various materials investigations were carried out. It was concluded that present epitaxial deposition processes are quite satisfactory for this type device. C.T.C.

N65-34468 Amphenol RF Div., Amphenol Corp., Danbury, Conn.
ULTRA STABLE MICROWAVE CABLE ASSEMBLIES Final Report, 1 Jun. 1961–1 Jun. 1965
C. A. Marohnic and Roger Avery 29 Jun. 1965 141 p
(Contract DA-36-039-SC-87467)
(Rept.-2004-17; AD-469676)

Pertinent electrical and mechanical features of the low loss microwave cable assemblies are described. Theoretical models of the cables and a summary of experimental data and final prototype cable designs and test reports are presented. The design, fabrication, and testing of the connectors developed for the cables are discussed. Experimental data taken of cable assemblies fabricated from the optimum models are presented. R.N.A.

N65-34498# Army Electronics Labs., Fort Monmouth, N. J.
STUDY OF AN M-TYPE BACKWARD-WAVE OSCILLATOR UTILIZING AXIAL BEAM INJECTION
Gunther E. Wurthmann, Park Richmond, and Paul Fisher Jun. 1965 41 p refs
(ECOM-2602)

Design, fabrication, and testing are discussed for a pulsed crossed field, M-type backward wave oscillator utilizing axial beam injection that permits selection of a lower power driver and gives more current than sole-emitting devices since axial dimension is not limited to quarter-wavelength. An external electromagnet provides the field. The crossed field gun, which feeds the beam axially into the interaction region, provides a degree of isolation between gun and wave structure. The electric field of the gun is strongest at the exit point of the structure and rapidly becomes weaker as it moves away from the interaction area. Only a small part of the cathode is effective since emission is strongly dependent on this field; to correct this unequal emission, tilting of the cathode was attempted, and it is suggested that the accelerator be tilted to a position nearly parallel to the cathode. An interdigital delay line serves as the periodic circuit of the device, and coupling to the external waveguide is accomplished with tapered sections at both ends of the periodic structure. M.W.R.

N65-34520# Michigan Univ., Ann Arbor. Electron Physics Lab.
FLUCTUATIONS IN PHOTON DETECTORS Technical Report No. 86
Gunnar Hok Aug. 1965 69 p refs
(Contract AF 33(615)-1553)
(Rept.-06349-10-T; AD-470157)

The description of the electromagnetic radiation field in terms of quantum mechanics is briefly reviewed. Expansions of the field in energy eigenstates and in coherent states are discussed as well as the invariance of the entropy under such transformations. The maximum entropy or channel capacity of an electromagnetic wave is compared with the classical result of communication theory. Statistical decision theory is applied to the study of an ideal photon counter, illuminated by a signal and background thermal radiation. The ideal counter is assumed to have 100 percent quantum efficiency and to show no other fluctuations than the zero-point field required by the

quantum postulates. Photoemission devices, i.e., photomultipliers and traveling-wave phototubes, are presented as modifications of the ideal detector and their noise properties are briefly analyzed. Solid-state photodiodes and photoelectromagnetic detectors are described from the same point of view and the signal-to-noise ratio of their output is presented. Author

N65-34527# Pittsburgh Univ., Pa. Sarah Mellon Scaife Radiation Lab.
PARTICLE PHYSICS AND NUCLEAR DECAY. CANCELLATION OF PHOTOMULTIPLIER GAIN DRIFT FOLLOWING SOURCE INTENSITY CHANGE Technical Report No. 1
James E. Brimhall and Lorne A. Page 31 Jul. 1965 95 p refs
(Grants DA-ARO(D)-31-124-G217; DA-ARO(D)-31-124-6689)
(AROD-3347-6; AD-619683)

A complete set of tests run on representative photomultiplier tubes is reported. From the testing a cancellation method evolved which uses a deliberate change in the high voltage to immediately erase the memory of each source intensity change. Empirical characteristic curves, relating anode current to high voltage subject to zero gain drift, are determined and extensively tested. The range of validity of the cancellation method in terms of ambient temperature, spectrum, and intensity level is explored. Although a limitation is found at higher temperatures (about 50° C), the characteristic curves are valid down to 0° C. It is established that the seat of these gain drifts is neither in the photocathode region nor in the anode region, and seems mostly likely to be distributed over the ten dynode surfaces. Also discussed are temperature sensitivities of photomultipliers, of NaI scintillators, of light-pipers, NaI afterglow, and grid control of tube current. A series of tests validating grid control by itself as a method of preventing gain drift, is presented. L.S.

N65-34530# Westinghouse Electric Corp., Baltimore, Md. Surface Div.
MICROELECTRONIC PACKAGING CONCEPTS Final Report
T. Hamburger and S. Gourse Griffiss AFB, N. Y., RADC, Jul. 1965 323 p refs
(Contract AF 30(602)-3285)
(RADC-TR-65-61; AD-619444)

All aspects of microcircuit packaging are studied and each of the three basic approaches to the packaging of microcircuits are investigated and evaluated. These three approaches are: (1) TO-type containers, (2) glass and metal flat packages, (3) encapsulated type packages. Evaluation is done in the areas of thermal properties, frequency limitations, form factor and ease of interconnection, reliability and cost. Construction details for each type of package are discussed and various commercially available microcircuit packages are cataloged. Thermal ratings of circuit packages are formulated with regard to power dissipation per circuit and allowable power densities in the system. Testing procedures are outlined to allow the thermal characterization of any microcircuit package. In this area, several curves are given showing the variation in case-to-ambient thermal resistance as a function of air flow and system power density. Conclusions are then drawn concerning the relative merits of each packaging approach. Author

N65-34534# Army Electronics Labs., Fort Monmouth, N. J. Electron Tubes Div.
TRANSIENTS IN HIGH-POWER MODULATORS
Sol Schneider and George W. Taylor Jun. 1965 21 p refs
(ECOM-2600; AD-619499)

The physical size involved in the design and construction of high-power modulators introduces high inductance and stray capacitance in the circuit. Analysis shows that under normal operation any inductance between the energy source and the rf device together with the stray capacitance produces damped oscillations after the "turn-on" and "turn-off" of the rf generator beam. Unfortunately, the need for adequate protection of the rf generator and modulator requires the introduction of an additional inductor in the circuit to limit the rate of rise or fault current. Improper placement of this inductor can also produce detrimental oscillations under fault conditions. Proper design can minimize these unwanted transients. An analysis of the circuit and the results obtained in a high-power modulator are discussed. Author

N65-34536# Motorola, Inc., Phoenix, Ariz. Semiconductor Products Div.
THIN FILM TECHNIQUES FOR SILICON INTEGRATED CIRCUITS Quarterly Progress Report, 1 Dec. 1964–28 Feb. 1965
C. D. Phillips and R. W. Wilson [1965] 79 p refs
(Contract DA-28-043-AMC-00097(E))
(QPR-3; AD-619946)

Flash evaporation of cermet resistive materials and plasma-anodized capacitor dielectrics was investigated. A problem encountered in flash evaporation of cermet materials was interference of the electron beam and magnetic field of the deflection system with the sheet-resistance monitoring circuit. Shielding the leads to the test sample and the thermocouple monitoring substrate temperature eliminated the interference. Leaks developed in the plasma-anodization system. The system has been repaired and is back in operation. Low-energy sputtering of cermet films has been investigated. Work on vapor-plated capacitor dielectrics has continued. Masks for the broadband linear amplifier circuit are now available and initial samples of the circuit are being processed. Initial samples of the thin-film logic gate are being analyzed. The thin-film compatibility study has not been started, since the resistive and capacitive materials have not been selected. This study should be underway shortly. Author

N65-34568# Microwave Associates, Inc., Burlington, Mass.
INVESTIGATION OF HIGH POWER GASEOUS ELECTRONICS Tenth Quarterly Progress Report, 16 Feb.–15 May 1965
H. S. Maddix [1965] 30 p
(Contract DA-36-039-AMC-00097(E))
(Rept.-10; AD-619421)

Gas clean-up was investigated in an X-band TR tube over a 20 to 300° C temperature range. An Arrhenius plot of chemisorption of water vapor in the bronze walls and brazing solder yielded an energy of activation of 6.0 kcal/mole. Negligible clean-up occurred in a 1 watt RF discharge between nickel cones. Clean-up due to a 100 μamp dc keep-alive discharge was independent of ambient temperature. Maximum clean-up of water vapor occurred at 20° C for a 10 watt RF discharge at a 7070 glass-kovar window. An energy of activation of 6.0 kcal/mole for clean-up at the window was measured. Diffusion controlling mechanisms were indicated because of the dependence of clean-up and chemisorption on the square root of time. Discharges in gas mixtures containing ammonia caused evolution of gas due to reduction of oxides formed in the water vapor discharges. Author

N65-34569# Raytheon Co., Waltham, Mass.
HIGH FREQUENCY TUNNEL DEVICE STUDY Final Report
S. R. Steel and A. Starr Griffiss AFB, N. Y., RADC, Jun. 1965 34 p refs
(Contract AF 30(602)-3249)
(RADC-TR-65-136; AD-619962)

The work reported here is aimed at investigating the feasibility of achieving low noise microwave amplification by using

tunneling. Studies of the temperature dependence of deterioration phenomena in Al–Al_2O_3–Au devices have yielded information about the failure mechanisms responsible for the short lifetimes heretofore obtained. Device failure is attributed to several causes. Flaws in the insulating film sometimes develop into partial shorts under the stresses of device operation. Ions migrating through the oxide layer may produce a change in the barrier. Ionic conduction currents may also cause some electrochemical dissociation of the insulator material. Overheating of the device during operation accelerates the destructive processes. Experimental results seem to indicate that aluminum oxide is not a useful material for the insulator in a tunnel emitter and that a more effective material must be found. Author

N65-34588* Purdue Univ., Lafayette, Ind.
RADIATION EFFECTS ON SEMICONDUCTING MATERIALS
H. Y. Fan *In* NASA. Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 121–122 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: HF $2.50

Irradiation with energetic particles produces lattice defects in semiconductors, various defect centers are formed, and macroscopic disordered regions in a crystal lattice may also be produced. Various properties of semiconductors, particularly the electronic ones, are affected by irradiation. With irradiation, a semiconductor may change its carrier concentration and electrical conductivity; even the type of semiconductor may be changed. Defect centers increase scattering of charge carriers and reduce carrier lifetime; excitation and ionization of defect centers produce photoconductivity in new wavelength regions and may result in luminescence emission bands and additional absorption bands. Physical dimension of a specimen may change because of strain introduced by defect centers and macroscopic disordered regions. M.W.R.

N65-34681# Clevite Corp., Palo Alto, Calif. Shockley Research Lab.
NEW CONCEPTS FOR SOLID STATE MICROWAVE GENERATORS Final Report, 1 Oct. 1962–28 Feb. 1965
R. M. Scarlett May 1965 125 p refs
(Contract DA-36-039-AMC-00001(E))
(ECOM-00001-F; AD-619080)

The basic theory of transit-time delay diodes is developed, and their maximum power output calculated. This output is about 7% of that calculated for conventional transistors on a similar basis, but the maximum operating frequency should be higher by a factor of order five. Calculations show the performance is very sensitive to the manner in which impurities are distributed in the base layer; because of unfavorable distributions, practical devices exhibit an unusually small negative resistance. PIN charge storage diodes made by epitaxy have transition times corresponding to theory. A theoretical treatment of transient forward and reverse charge storage is applied to harmonic generator calculations. It appears that PIN diodes may be superior to conventional varactors up to several Gc. Preliminary experimental results are encouraging. The first-order theory of a new amplifying device principle, termed the Surface Controlled Avalanche Transistor, is presented. This device appears promising as a microwave amplifier up to several Gc for relatively high power. Initial experimental devices performed approximately as expected, showing no decrease in transconductance up to 1 Gc. The drift in characteristics with time is still a serious problem, and the MOS capacitor method was used to evaluate various oxides for stability under large electric fields. Author

N65-34687# CTS Knights, Inc., Sandwich, Ill.
HIGH PRECISION 5 MC QUARTZ RESONATORS FOR TEMPERATURE CONTROL BETWEEN 20° AND 30°C, 10 MARCH 1965–JUNE 1965
[1965] 31 p refs
(Contract NObsr-89290)
(Rept.-VIII; AD-619735)

The aging rates of typical room temperature, 5th overtone, 5mc resonators, during the first 2 to 9 weeks are used to show that a very significant gain appears to have been achieved by designing units for operation near the inflection temperature. Author

N65-34705# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
A PHASE SHIFT METHOD OF DETERMINING MILLICROSECOND FLUORESCENT LIFETIMES OF ORGANIC SUBSTANCES IN AERATED SOLUTIONS
Grant David Callin (M.S. Thesis) Mar. 1965 96 p refs
(GSP/PH/65-4; AD-618095)

An apparatus is presented to measure fluorescent lifetimes of organic substances in aerated solutions. The apparatus employs the phase shift method of measurement, which is useful for determining lifetimes in the range of 10^{-7} to 10^{-9} seconds. When a fluorescent substance is irradiated by light modulated at frequency ω, the fluorescence is modulated at the same frequency but phase shifted by an angle ϕ. This angle is measured by the electrical system of the apparatus, and ω is known; the lifetime τ is then calculated with the phase shift formula $\tan \phi = \omega\tau$. The phase shift apparatus is described with respect to function, performance, and error sources, and an experimental procedure is recommended for use with the device. The fluorescent lifetime of perylene was measured to evaluate the system performance and found to be $5.1 \pm 0.5 \times 10^{-9}$ seconds. This value was in close agreement with that found by Ware for the same substance, using the same method of measurement. Author

N65-34711# Lockheed Missiles and Space Co., Sunnyvale, Calif.
TABLES OF CAPACITOR DISCHARGE IN TRANSIENT GAMMA RADIATION ENVIRONMENTS
De Witt Landis 1 Mar. 1965 82 p
(AD-617918)

The tables in this report give the response of various types of capacitors to various transient gamma radiation environments. The tables were generated on a digital computer. The parameters used to characterize the capacitors were obtained from the *TREE Handbook* and "Analytical Methods for Predicting Transient Nuclear Radiation Effects on Electronics Circuits and Devices." The capacitor parameters in these reports represent only the average response of many similar capacitors to many different radiation environments. Unit-to-unit and manufacturer-to-manufacturer variations in the capacitors make it impossible to predict the effects of radiation exactly, so these tables should be considered as giving only a "typical" response of the particular capacitor to the given radiation environment. Assuming, however, that the capacitor parameters from the above reports are exact, then it is believed that the numbers given in the tables, with a few exceptions discussed later, are accurate to three significant figures. Author

N65-34717# Motorola, Inc., Scottsdale, Ariz. Military Electronics Div.
VISTAR FIELD ENGINEERING Final Report, 1 Jan. 1964–31 Mar. 1965

Herbert Bretzel and Glenn Kinzer 30 Apr. 1965 66 p
(Contract AF 19(628)-4018)
(WF-2982; AFCRL-65-354; AD-617932)

Field engineering accomplishments are presented for an airborne radar instrumentation program. It is reported that modifications in the program plans include ground operation only. Transmitter/receiver modifications and data processor work is given. Circuit diagram corrections and additions are also given, and a set of subassembly identification pictures are included. An alternate approach to the airborne radar instrumentation is presented. This includes a high duty cycle, low peak power (120 watts), half-microsecond magnetron transmitter to reduce weight. Coherence is established in the receiver via delay-line storage of the transmitter pulse, heterodyned to an if frequency (55 Mc). Tape recording of the Doppler spectrum at 25 range intervals provides the history necessary for spectral analysis on the ground after flights. An antenna that employs electromechanical stabilization of the beam to compensate for pitch motion of the aircraft is discussed. C.T.C.

N65-34724# Lincoln Lab., Mass. Inst. of Tech., Lexington.
ANALYSIS OF RADIATION EFFECTS IN TELEMETRY CIRCUITS Technical Note No. 1965-20
Alan G. Stanley 21 Jul. 1965 30 p ref
(Contract AF 19(628)-5167)
(ESD-TDR-65-310; AD-619387)

The effects of nuclear radiation on the telemetry circuits in the LES satellites have been analyzed by direct irradiation and by simulating the effects on individual components on a breadboard circuit. The simulation method is described in detail. It requires a precise knowledge of the behavior of each component operating under specified bias conditions in a radiation environment, but may be applied to circuits of considerable complexity. The analysis confirmed that circuits such as the flip-flop, which operate at 50 percent duty cycle, are insensitive to moderate leakage currents and have low gain requirements, are extremely radiation resistant. The converse holds for circuits that operate at low duty cycles, that are sensitive to leakage currents and that have more stringent gain requirements. Author

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N65-33791# Boeing Co., Seattle, Wash.
AN ANALYSIS OF PULSE-FREQUENCY MODULATED CONTROL SYSTEMS
James P. Clark 24 May 1965 161 p refs
(D2-23969-1; AD-464960)

A particular form of pulse-frequency modulated control system is analyzed with three main objectives: (1) to obtain point transformation equations for a general closed loop system, (2) to examine stability, and (3) to gain an insight into the limit cycle characteristics of such systems by considering a simple form. The type of system considered is a class of sampled-data systems, but differs from the more conventional forms in two major respects. First, the sampling periods vary as a function of the error instead of following a predetermined pattern. Secondly, the driving function is a train of standard pulses with constant amplitude and constant width. A pulse-frequency modulator determines the time to the next pulse on the basis of amplitude of error and assigns the pulse polarity. Author

N65-33898# Dikewood Corp., Albuquerque, N. Mex.
EXTRAPOLATING ELECTROMAGNETIC FIELDS FROM VALUES IN A SPHERICAL REGION Technical Report, Oct. 1964-Mar. 1965
D. D. Babb and K. D. Granzow Jun. 1965 62 p refs
(Contract AF 29(601)-6634)
(WL-TR-64-179; AD-617965)

The region outside the sphere is considered to be homogeneous, isotropic, source free, and nonconducting, except that application of the method of images allows the introduction of an infinitely conducting ground plane. Solutions of the scalar wave equation are made applicable by expressing the spherical harmonic expansion coefficients of the rectangular components in terms of the coefficients of the spherical components. Two methods are developed for obtaining time dependent solutions for fields at points outside the sphere without invoking Fourier analysis. One method results from inserting the expansions of the rectangular components into the Kirchhoff integral solution of the wave equation. The other method involves eliminating the explicit frequency dependence of the eigenfunction solution of the wave equation by introducing a differential operator to replace the Hankel function. These methods are useful when the source has a very wide-band frequency spectrum, so that it is best described in the time domain. This is the case with electromagnetic pulses from nuclear detonations. Author

N65-33932# Union Carbide Nuclear Corp., Oak Ridge, Tenn.
AN ACCELERATION SWITCHING VALVE CONTROL SYSTEM WITH MACHINE TOOL APPLICATION
J. B. Mankin 27 Sep. 1965 121 p refs
(Contract W-7405-ENG-26)
(Y-1488) CFSTI: $4.00

With equal emphasis on practice and theory, the application of the acceleration switching valve to machine tool control systems is examined. Utilizing basic hydraulic concepts and electrical anaology techniques, the differential equation describing the acceleration switching valve and its associated load is developed. Root locus techniques are then utilized to synthesize a feedback control system with desireable transient response and steady-state errors. Physical tests are performed to verify all results. Author

N65-33946# National Gas Turbine Establishment, Pyestock (England).
ELECTRONIC INTEGRATION USING A FEEDBACK AMPLIFIER
W. D. Bryce Mar. 1965 38 p refs
(NGTE-M-396) CFSTI: HC $2.00/MF $0.50

In the field of instrumentation it is often desired to obtain the time integral of an alternating electronic signal. This report describes the theoretical performance of a particular type of integrating voltage amplifier using capacitive feedback and shows how the basic performance may be improved by the use of RC compensating circuits. While the amplifier has been intended to achieve accurate single and double integration between wide frequency limits, an important aspect influencing the design is possible interference by signals occurring outside the frequency range of interest. The characteristics of an actual amplifier, designed according to the theory presented, confirm that the theoretical performance may be attained in practice. The best amplifier performance is, however, gained at the expense of greater setting-up and calibration effort. Author

N65-34008*# General Electric Co., Daytona Beach, Fla. Apollo Support Dept.
SINGLE PARAMETER TESTING Final Report
E. L. Berger, J. C. Jackson, and J. T. Sterling Aug. 1965 98 p refs *Its* Rept.-65-SIMAR-89/7
(Contract NAS8-11715)
(NASA-CR-64975) CFSTI: HC $3.00/MF $0.75 CSCL 09C

A method was established for the testing of active and passive transfer functions. The method was used on several transfer functions and accuracy and measurement time proved to be as good or better than present methods of checkout. Faster checkout time is a direct result of the methods studied. Less degradation due to performance is a direct result of using smooth probing signals. Accuracy is acceptable over a parameter range of ±10% or more. R.N.A.

N65-34011# Illinois Univ., Urbana. Coordinated Science Lab.
ON THE GENERALITY OF SWITCHING NETWORKS WITH RESTRICTED NON-LINEARITY
A. C. Mc Kellar Jun. 1965 17 p refs
(Contract DA-28-043-AMC-00073(E); Grant NSF GK-361)
(R-258; AD-618331)

The generality of special types of asynchronous realizations of sequential machines is considered and compared with the synchronous case. It is shown that linear asynchronous networks are essentially combinational. On the other hand, every sequential machine can be realized as a network whose output and feedback functions are linear in the feedback inputs. It is proven that more feedback loops are required to do this than are required by known synchronous realizations. A relationship is established between asynchronous networks which are quadratic in their feedback inputs and synchronous networks which are linear in their feedback inputs. Author

N65-34140# Air Force Cambridge Research Labs., Bedford, Mass. Data Sciences Lab.
STATE—LOGIC RELATIONS IN AN ITERATIVE STRUCTURE FOR AUTONOMOUS SEQUENTIAL MACHINE
William F. King, III Jun. 1965 22 p refs *Its* Phys. and Mathematical Sci. Res. Papers No. 112
(AFCRL-65-439; AD-619806)

The purpose of this paper is to determine the state–logic relations in an iterative structure for any autonomous sequential machine. A model is used in which delay is distributed throughout the machine. Theorems are presented which prescribe the interconnection of identical elements to realize any autonomous sequential behavior. Synthesis, as described here, yields a more costly machine in terms of delay elements than those of previous workers. In addition to the iterative structure, increased speed of operation is the advantage brought by the extra delay elements. Author

N65-34238*# Martin Co., Denver, Colo.
CONTACT TRANSFORMATIONS AND THE THEORY OF OPTIMAL CONTROL
R. S. DeZur and G. W. Haynes Washington, NASA, Sep. 1965 29 p refs
(Contract NAS2-2351)
(NASA-CR-306) CFSTI: HC $2.00/MF $0.50 CSCL 12A

The main results achieved are as follows: (1) The primary advantage in using contact transformations is that if the Hamilton–Jacobi partial differential equation can be reduced to a linear partial differential equation by a suitable contact transformation, then the number of ordinary differential equations required to generate a solution are reduced. (2) The Hamilton–Jacobi theory is inadequate, not because of the discontinuities introduced by the bounded controls, but because of the lack of sufficient conditions required to resolve the singular problem. (3) A new system of partial differential equations characterizing the control problem with an enlarged control set has been derived in conjunction with a new optimization procedure. Author

N65-34291# Northwestern Univ., Evanston, Ill. Technological Inst.
TOPOLOGICAL ANALYSIS OF ACTIVE NETWORK AND GENERALIZATION OF HAMILTONIAN TREE
Narsingh Deo (Ph.D. Thesis) Jun. 1965 124 p refs
(AROD-3298-19; AD-468706)

The analysis of linear active networks by topological means presented here used Hakimi's efficient method of tree generation. Unlike many other methods, no tree can ever be generated twice, and every tree has been accounted for. Moreover, no separate computations are needed for signs because each tree generates its own sign. As soon as a complete tree is generated, its admittance product is added to (or subtracted from) the rest, and thus very little storage space is required. A linear programming solution of the generalization of the Hamiltonian tree problem is also presented. The simplex method with bounded variables is used to generate the first optimal solution. In a side loop this solution is tested to see if the subgraph is a tree. If not, an alternate optimal solution, or the next best solution, is generated and tested. This process is continued until the required least-weight tree is obtained. An alternative method based on a combinatorial search is also outlined Author

N65-34718# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
APPLICATION OF MULTIPLE FIXED COMPENSATORS TO ACHIEVE INVARIANT RESPONSE
Jordan L. Dorrity (M.S. Thesis) Jun. 1965 73 p refs
(GGC/EE/65-4; AD-619036)

This report presents techniques for the design of a system which uses multiple fixed compensators to provide invariant aircraft response. The frequency response method of analysis is used and the criteria for choosing the number of compensators and switching time are given. Dynamic pressure is the only factor used to determine the flight conditions for switching. An application of the techniques to the X-15 pitch-rate loop proved them to be very realistic. The command response was very nearly the same for all flight conditions and the gust response was attenuated quickly. Switching transients were not found to be undesirable. Author

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N65-33613* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DISCUSSION OF EXISTING AND PLANNED SIMULATORS FOR SPACE RESEARCH
A. W. Vogeley *In* Va. Polytech. Inst. The Role of Simulation in Space Technol., Pt. C [1964] 40 p (See N65-33611 22-30) CFSTI: HC $6.00/MF $1.50

A variety of manned flight simulations particularly applicable to space research are discussed. Most of the simulators described are in operation, but are relatively new; some are still under construction or in the planning stage; and several simulators are nonexistent. It is pointed out that flight simulation in space research is very important because every effort has been made to solve all possible problems before the first flight in the space program. Subject areas covered include basic simulator components; the art of flight simulation; types of simulators; manned space mission phases; earth launch and reentry; rendezvous; docking; onboard simulators; orbital operations; lunar landing; and earth landing. R.R.D.

N65-33614* Pennsylvania Univ., Philadelphia.
VISUAL AND MOTION SIMULATION TECHNIQUES
John Lott Brown *In* Va. Polytech. Inst. The Role of Simulation in Space Technol., Pt. C [1964] 34 p refs (See N65-33611 22-30) CFSTI: HC $6.00/MF $1.50

Vision and motion simulation techniques in space research are discussed. Among the visual tasks important in space flight are the discrimination of size, distance, and relative motion. These are directly applicable to the primary concern with simulators which provide a basis for testing man's performance in a continuous task situation, such as the control of a moving vehicle. Other topics covered include sensory integration; value of motion simulation; techniques of motion simulation; linear acceleration components; centrifuge simulation; and psychological stress. R.R.D.

N65-33633 Inter-Range Instrumentation Group, White Sands Missile Range, N. Mex. Meteorological Working Group.
METEOROLOGICAL ROCKET NETWORK STATIONS
In its Meteorol. Rocket Network Feb. 1965 p 11-154 (See N65-33632 22-31)

Brief descriptions of the facilities, geography, climatology, range instrumentation, and meteorological rocket sounding systems for 22 meteorological rocket network launch stations are presented. Considered were only those stations which are equipped to fire, or which have fired, meteorological rockets. Included are graphs depicting the chronological summaries of cumulative firings from the individual stations. G.G.

N65-33680# Philco Corp., Palo Alto, Calif. Western Development Labs.
INTEGRATED SYSTEMS CHECKOUT. NEW BOSTON TRACKING STATION. MULTIPLE SATELLITE AUGMENTATION PROGRAM Utility Technical Manual
15 Nov. 1963 68 p
(Contract AF 04(695)-113)
(WDL-TM-3103-4; AD-460876)

Information and instructions required to perform an integrated system checkout of the subsystems installed under Phase A of the Multiple Satellite Augmentation Program (MSAP) are presented. These include a definition of the purpose, main features, and site layout of the subsystems; the processing of acquisition, tracking, telemetry, and command data; and a checkout procedures from the telemetry, command, acquisition, and tracking loops. R.R.D.

N65-33701*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SOME RECENT DEVELOPMENTS IN BALLISTIC-RANGE EQUIPMENT AND TESTING TECHNIQUES
[1964] 15 p refs Presented at the 6th Meeting of the ARA, Aberdeen Proving Ground, Md. and Lexington Mass., 11-13 Mar. 1964
(NASA-TM-X-51876) CFSTI: HC $1.00/MF $0.50 CSCL 14B

This paper describes several innovations in testing technique and equipment in use in the ballistic-range facilities at the Ames Research Center of NASA. In addition, a listing, with pertinent dimensions of the test facilites and launching guns, is included. Author

N65-33727# ARO, Inc., Arnold Air Force Station, Tenn.
LOW DENSITY BOUNDARY LAYER CONTROL BY LIQUID HYDROGEN CRYOPUMPING
W. N. Mac Dermott, R. E. Dix, and B. H. Shirley Arnold Eng. Develop. Center, Aug. 1965 29 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-65-148; AD-467446)

Thick boundary layers in a low density wind tunnel nozzle have been reduced by applying suction on the diverging walls of the nozzle. Extremely high suction rates have been established by cryogenically pumping the boundary layer gas directly to the wall. The experimental apparatus used in this study incorporates a 12-in.-diam hypersonic nozzle and a 16-in. primary liquid hydrogen cryopump with a pumping speed of 200,000 liters/sec. Comparison of pitot and static pressures measured in this nozzle with nitrogen at an upstream settling chamber temperature of 300° K indicates a supersaturated isentropic flow regime bounded on the low pressure end by a merged boundary layer. This nozzle has also been supplied with arc-heated nitrogen, and it has been found that the wall cryopumping retains effectiveness at suppply temperatures at least as high as 4000° K, although for a lesser period of time and at lower efficiency. When operating this apparatus with an arc heater, evidence has been found that there are some nitrogen atoms formed in the arc discharge which survive the expansion flow through the nozzle and are trapped on the cryogenic surfaces in atomic form. Author

N65-33740# Rohm and Haas Co., Huntsville, Ala. Redstone Arsenal Research Div.
E-RANGE INSTRUMENTATION Special Report
James E. De More 10 Sep. 1965 29 p
(Contract DA-01-021-AMC-11536(Z))
(S-66; AD-469355)

E-Range Instrumentation is a central instrumentation facility designed to serve a number of test areas located at distances up to 1500 feet. The principal parts of the system, the calibrators, the Fire Control, the pin board, and the analog and digital recording systems, are described in detail. Author

N65-33875*# Motorola, Inc., Scottsdale, Ariz. Military Electronics Div.
MARINER "C" DSIF EQUIVALENT GROUND SUPPORT EQUIPMENT, VOLUME I Final Report
D. E. Morton and H. W. Nelson 15 Aug. 1964 181 p *Its* Doc.-68-25299E Prepared for JPL
(Contracts NAS7-100; JPL-950879)
(NASA-CR-64894; WF-3006-1) CFSTI: HC $5.00/MF $1.25 CSCL 22D

This document is a final report on the Mariner "C" DSIF Equivalent Ground Support Equipment: The report is composed of a detailed description of the system and subassemblies, theory of operation, test setups and procedures including detailed alignment procedures with tolerances, the results of developmental investigations, and schematics, block diagrams, and other pertinent data. Author

N65-33903# Naval Research Lab., Washington, D. C.
DATA FROM A SYSTEM OF ATMOSPHERIC ELECTRICITY STATIONS Interim Report
Eva Mae Trent and R. V. Anderson 20 May 1965 400 p refs
(NRL-6162; AD-618206)

Naval Research Laboratory Semiautomatic Atmospheric Electricity Stations were installed at Naval Air Stations in Argentia, Newfoundland; Lakehurst, New Jersey; Norfolk, Virginia; and Pensacola, Florida. These stations were instrumented to provide recordings of both polar conductivities and of electric field. The data are presented in tabular form listing daily, hourly averages of total conductivity, ratio of the two polar conductivities, potential gradient, and selected weather observations taken from WBAN reports. The tables list data for the period between installation and December 1, 1961. Graphs of seasonal hourly averages of conductivity in fog and in fair weather are presented. Author

N65-33904# Naval Civil Engineering Lab., Port Hueneme, Calif.
NUMERICAL ANALYSIS FOR TWO-LAYERED PAVEMENT SYSTEMS Final Report
W. L. Wilcoxson and J. P. Nielsen Jul. 1965 79 p refs
(R-378; AD-618064)

Techniques are presented for numerically evaluating the Burmister integral expression for the settlement coefficient at ground level, F_w, in a layered-pavement system. Also, an economical and efficient means of evaluating F_w is demonstrated, along with means for estimating the error associated with each evaluation. The influence curves presented will find immediate application in the design of airfield pavements and in the evaluation of existing runways. Included in a series of appendixes are the technical details for evaluating the settlement coefficient and data for constructing additional curves. Author

N65-34025# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
SIXTH ANNUAL SYMPOSIUM ON SPACE ENVIRONMENTAL SIMULATION
[1965] 202 p refs Symp. held at St. Louis, 17–18 May 1965
(AD-465701)

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10. DESIGN OF NASA-LEWIS SPACE PROPULSION FACILITY D. J. Pearse (Kaiser Eng.) 18 p (See N65-34035 22-11)

N65-34026 Little (Arthur D.), Inc., Cambridge, Mass.
EXPERIMENTS WITH A LIQUID HELIUM CRYOPUMPED EXTREME HIGH VACUUM SYSTEM
R. W. Moore, Jr. *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 17 p refs (See N65-34025 22-11)

To produce an ultraclean environment in simulating lunar surface and interplanetary space conditions, a liquid helium cryopumped vacuum system was built to achieve pressures of 10^{-12} torr. Cryogenics is employed to make outgassing from the test space walls negligible by cooling them to near 80° K and to provide high pumping speeds at low pressures by a cryopumping surface adjacent to the test surface maintained at 4.2° K. Boil-off of liquid nitrogen and liquid helium provides the necessary refrigeration. Discussed are experiments to achieve low temperatures, hydrogen injection at the warm end of the inner vessel, and pumping nitrogen and hydrogen from the test space. The initial helium supply permits a four-day run of the system before an additional supply is required and the nitrogen cylinder must be replaced about once each day. The thermal inertia of the system is such that the temperature of the inner vessel does not rise appreciably during a changeover. M.W.R.

N65-34028 Celestial Research Corp., South Pasadena, Calif.
THE MAINTENANCE OF HIGH VACUUM CONDITIONS FOR ROCKET TESTING
R. L. Chuan and D. A. Wallace *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 16 p refs (See N65-34025 22-11)

The cryopump, which provides high mass flows at low pressures, is considered as a technique to provide the high pumping speeds required for testing rocket motors. Some of the difficulties involved in cryopump design are discussed, and formulas for solving for various conditions are introduced. Pressure-rise characteristics are plotted as a function of rocket thrust; vapor pressures of MMH–N_2O_4 combustion products are shown graphically. Also illustrated are the probability of both wall collision and direct back-reflectance for directed flow in tubular elements. The concentration gradient resulting from a non-unity sticking coefficient is shown, as is molecular flux into the "n-flow" region. M.W.R.

N65-34029 McDonnell Aircraft Corp., St. Louis, Mo.
GEMINI SPACECRAFT ORBITAL SIMULATION PROGRAM
F. W. Fults and W. J. Rock *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 19 p (See N65-34025 22-11)

A production Gemini Spacecraft, consisting of the mated adapter and re-entry sections, was recently subjected to an orbital simulation program in a 30-foot diameter vacuum-thermal chamber to determine the thermal equilibrium characteristics of the spacecraft. Of prime interest was an evaluation of the spacecraft's environmental control system and coolant system under various flight configurations and operating modes. This paper describes the three tests conducted and the techniques employed to simulate the space environment. Problems encountered and their solutions are also discussed. Author

N65-34030 Eppley Lab., Inc., Newport, R. I.
THE EVOLUTION OF SOLAR SIMULATOR TESTING AND EVALUATION TECHNIQUES

A. J. Drummond and J. R. Hickey *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 25 p refs (See N65-34025 22-11)

The establishment of the need for solar simulation capabilities in ground test facilities for space vehicles necessitated advancements in the art of evaluating shortwave (solar) radiation. Concurrently with the effort to produce adequate solar simulation, a program has been established, to provide instruments and techniques for the evaluation of the artificial sun. Not only is it necessary to obtain spectral and total irradiance values under simulated space conditions, but also important is re-examination of the validity of available data on the real extraterrestrial fluxes. This paper reviews the development of measurement instrumentation and test and evaluation techniques. The problems encountered at certain of the various solar simulator facilities will be discussed. The results obtained by differing test techniques are presented in summary form. The problem of true solar evaluation with a brief resume of current information is included. The methods for calibration of measuring systems are discussed. Recommendations for standardized techniques and evaluations are made. Author

N65-34031 Atomics International, Canoga Park, Calif.
INFLUENCE OF PRODUCT CONTAMINANTS ON VACUUM AND FLIGHT SYSTEM PERFORMANCE
Stuart Giles *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 16 p refs (See N65-34025 22-11)

The effect of cleaning on vacuum system performance reveals that vacuum system base pressure at 1000° F can be reduced from 5×10^{-5} torr to 2×10^{-7} torr. Cleaning of the motor and the chamber load results in reducing the pump load by a factor of 330 to one; and size, cost, and reliability of the vacuum pumping system are found to improve after careful decontamination. Recommendations for operation of diffusion pump systems are listed. A discussion of environmental effects on creep properties of structural materials is included. M.W.R.

N65-34032 Lockheed Missiles and Space Co., Sunnyvale, Calif.
MATERIALS IN THE SPACE ENVIRONMENT
F. J. Clauss *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 45 p refs (See N65-34025 22-11)

Behavior of various materials in space environments is summarized and experimental results obtained under simulated space conditions are discussed. Tables present information on (1) behavior of organic encapsulating materials exposed to vacuum, temperature, and radiation; (2) results of vacuum exposure on foam-in-place encapsulating materials; (3) effect of high vacuum and elevated temperature on physical and mechanical properties of typical elastomers and plastics; (4) commercial adhesive types subjected to high vacuum, radiation, and elevated temperature; and (5) results in air and vacuum for ball bearings lubed with oil. Results with selected oils and greases as well as electrical noise behavior of metal-to-metal contacts in vacuum are also tabulated. Graphs present data on effect of atmospheric pressure on radiation damage to Teflon, and effect of time after irradiation on dissipation factor of Teflon at 500 cps. A circuit diagram is given for measuring electrical noise across slip-ring brushes, and the effect of near-ultraviolet radiation in vacuum on solar absorptance is shown. M.W.R.

N65-34033 Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
A COMPARISON OF SLIP RING AND ROTARY TRANSFORMERS FOR ELECTRICAL POWER TRANSMISSION TO GIMBAL MOUNTS IN SPACE SIMULATORS
Marshall K. Kingery *In its* 6th Ann. Symp. on Space Environ. Simulation [1965] 18 p refs (See N65-34025 22-11)

Environmental tests of six-months duration simulated planet, albedo, solar, heat sink, and hard vacuum space conditions to study slip rings and rotary transformers for transmitting electrical power across the rotating interface of the gimbal mount. Slip rings were found to be well suited for power transmission because they are small, long-lived, and economical to build. For powers of 100 kw and up, rotary transformers are relatively maintenance free and are considered better. Since the electrical conductors of slip rings must be exposed to the vacuum environment, the possibility of arcing due to unanticipated pressure is created; this hazard can be avoided by use of a rotary transformer because its electrical conductors can be hermetically sealed. If several signals are superimposed on one carrier, slip ring and transformer capabilities are about equal; the transformer, however, should create less noise. It is concluded that both slip ring and transformer have specific applications in space chambers; the former has been demonstrated to work, whereas the latter has been shown to be feasible and has not as yet been tested in operation. M.W.R.

N65-34035 Kaiser Engineers, Oakland, Calif.
DESIGN OF NASA--LEWIS SPACE PROPULSION FACILITY
Douglas J. Pearse *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 18 p (See N65-34025 22-11)

Facility arrangement, operation, vacuum and cryogenic systems, instrumentation, data acquisition, and controls are discussed for the multi-purpose environmental NASA Propulsion Facility now under construction. Testing capabilities will permit studies relating to nuclear–electric test articles, chemical rocket start-up after soak in the space environment, vehicle vibration tests, and other large space vehicle systems and satellite tests. The test chamber, a 100 ft diameter aluminum cylinder with hemispherical head and flat floor, is 122 ft high from floor to crown. Temperature capabilities are from +180° F to −300° F and pressure range is from atmosphere to 1×10^{-8} torr. Unique design features of the space propulsion facility are discussed, including design constraints, aluminum–aluminum clad test chamber, external cryogenic shroud, floor-mounted diffusion pumps, concrete enclosure and other radiation protection considerations, and flexibility of the three main areas. M.W.R.

N65-34255# Advisory Group for Aeronautical Research and Development, Paris (France).
UNITED STATES AIR FORCE ARRESTING GEAR FOR ALL-WEATHER OPERATION
P. D. Kennedy Oct. 1964 33 p refs
(AGARD-493) CFSTI: HC $2.00/MF $0.50

This report discusses the developments in the field of aircraft arresting barriers within the United States Air Force (USAF). The USAF has thus far accepted the arresting gear as a device to be used only under emergency conditions rather than as a method for routine stopping of aircraft. Nevertheless, wide acceptance has been gained for arresting gear. Arresting hooks have been installed on all USAF fighter aircraft to improve engagement reliability over that of the barrier webbing systems used previously and still in use for trainer aircraft. In addition, a computer controlled cabled throwing device has been developed for engagement of aircraft not equipped with arresting hooks such as trainer, bomber, and tanker type aircraft. Several rotary type energy absorbers have evolved from both USAF and United States Navy (USN) development

programs. These developments have resulted in the acquisition of arresting equipment capable of absorbing over 100 million foot-pounds of kinetic energy at engaging speeds up to 190 knots. Author

N65-34334# General Electric Co., Philadelphia, Pa. Missile and Space Div.
RESEARCH STUDY OF THE BIOMEDICAL ASPECTS OF AEROSPACE SYSTEMS ENVIRONMENTAL CHAMBER MARK I. PHASE VI: RAPID REPRESSURIZATION OF SPACE SIMULATION CHAMBERS Technical Report, Jul. 1964–May 1965
J. H. Jones, R. J. Berman, and B. Weichbrodt Arnold Eng. Develop. Center, Aug. 1965 137 p refs
(Contract AF 40(600)-1012)
(AEDC-TR-65-179, Vol. III; AD-469040)

Trouble free rapid repressurization of space simulation chambers is possible using a simple easily obtained muffler. Expected adverse dynamic and acoustic phenomena were eliminated during chamber tests. Heat transfer during the repressurization period was by forced convection; free convection predominated afterwards. Fogging occurs during ambient air repressurization when the cryowall is cold. An open cycle fan-heater system should eliminate this fog annoyance Author

N65-34335# ARO, Inc., Arnold Air Force Station, Tenn.
DESIGN AND INITIAL CALIBRATION OF A MAGNETIC SUSPENSION SYSTEM FOR WIND TUNNEL MODELS
C. D. Crain, M. D. Brown, and A. H. Cortner Arnold Eng. Develop. Center, Sep. 1965 70 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-65-187; AD-470147)

The design, construction, and initial calibration of a prototype magnetic suspension system capable of supporting models in a wind tunnel are described. Magnetically supported models allow measurements free from the interferences produced by mechanical model supports. The described system is of the "V"-type configuration and is compared to other types of configurations. Initial force calibration data are given, and it is concluded that quantitative force data would be difficult to obtain from the prototype suspension system because of the many interactions involved. This system was, for the most part, designed in 1959 and does not represent the state-of-the-art insofar as magnetic suspension systems are concerned. Recommendations for future magnetic suspension system designs are included as well as a discussion of the types of aerodynamic testing where the use of such a system might be beneficial. Author

N65-34368 European Organization for Nuclear Research, Geneva (Switzerland).
EXTRAPOLATION CHAMBER FOR SURFACE DOSE MEASUREMENTS
S. Charalambus and J. Baarli 28 Jun. 1965 22 p refs
(CERN-65-25) CFSTI: HC $1.00/MF $0.50

A portable extrapolation chamber to measure the dose-rate at the surface of pieces of radioactive materials is described. The problems connected with the computation of dose rate from the cavity ionization, the operation and some characteristics of the chamber are also discussed. Experimental results from measurements of surface dose rates of materials exposed to the high energy radiation of CERN accelerators are presented. Author

N65-34404*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FREE-FLIGHT TELEMETRY TESTING IN THE JET PROPULSION LABORATORY WIND TUNNELS
John T. Welton 15 Sep. 1965 14 p refs
(Contract NAS7-100)
(NASA-CR-67114; JPL-TR-32-775) CFSTI: HC $1.00/MF $0.50 CSCL 14B

A program was conducted in a hypersonic wind tunnel to develop an operational technique for obtaining interference-free base pressure data. The technique developed utilizes a pneumatic launch mechanism to project the models into free flight and an electronic transmitter and receiver system to obtain base pressure data from the model. Both 10° and 15° half-angle cone configurations were tested. Author

N65-34411*# Collins Rdio Co., Dallas, Tex.
GSFC FOUR STATIONS, ROSMAN I SYSTEM TEST Final Report
R. T. Hart 17 Apr. 1964 69 p *Its* Rept.-523-0556301-001D3M
(Contract NAS5-2462)
(NASA-CR-67149) CFSTI: HC $3.00/MF $0.75 CSCL 14B

To determine the performance capability of the 85-foot-diameter parabolic antenna constructed on an X-Y mount, a test program was conducted on site, and data are presented for both system performance and system calibration. The static tests, undertaken to determine the functional capabilities of each subsystem is related to the overall tracking accuracy, covered the parameters expected from operational conditions. These included pointing capability of the optical encoder system; and tracking receiver, servo, and tracking loop performances. In the dynamic tests, performed to determine system capability throughout the range of parameters expected in actual operation, satellite tracks and aircraft carrying equipment to simulate satellite signals were used. A sun track and a radio star track complemented the other tests. From this data, two sets of system characteristics were determined: the rms tracking accuracy in X and Y angles; and instrument alignment parameters that relate dynamic tracking errors to specific terms. Each test is described, and the results are tabulated. M.G.J.

N65-34436*# National Aeronautics and Space Administration, Washington, D. C.
WEIGHT/PERFORMANCE MANAGEMENT SURVEY MANUAL
15 Aug. 1965 34 p ref
(NASA-SP-6006; CM-017-041-1) CFSTI: HC $2.00/MF $0.50 CSCL 05A

The manual provides procedures for a management audit of NASA Apollo program contractor activities, assesses performance towards objectives, evaluates effectiveness of the management system, and where weaknesses exist, it provides a tool for determining corrective action. Author

N65-34441# Stanford Univ., Calif. Stanford Linear Accelerator Center.
TWO-MILE ACCELERATOR PROJECT Quarterly Status Report, 1 Jan.–31 Mar. 1965
Jun. 1965 112 p refs
(Contracts AT(04-3)-400; AT(04-3)-515)
(SLAC-45) CFSTI: $4.00

The following data on the construction of the two-mile-long linear electron accelerator are reported: plant engineering, systems engineering and installations, accelerator physics, instrumentation, heavy electronics, mechanical design and fabrication, klystron studies, beam switchyard, and pre-operations research and development. R.W.H.

N65-34465*# RAND Corp., Santa Monica, Calif.
A NETWORK APPROACH TO PARTS PROVISIONING FOR APOLLO PRELAUNCH OPERATIONS
R. B. Brooks and R. H. Haase Sep. 1965 88 p refs
(Contract NASr-21(08))
(NASA-CR-64901; RM-4581-NASA) CFSTI: HC $3.00/MF $0.75 CSCL 22D

A replacement-parts policy developed for Apollo prelaunch operations represents the scheduled operations as a project network with measures of both cost and effectiveness. Unscheduled activities, associated with replacement of malfunctioning parts, are represented by adding arcs to the nominal network. The procedure for each resupply capability includes identification of parts that do not have to be stocked, determination of a sequence of stock levels for the given resupply, estimation of expected measure of effectiveness for each replacement-parts policy, and development of the corresponding cost-effectiveness curve. To accomplish the procedure, four computer programs have been set up for the IBM 7044: parts reduction and network reduction programs and stock selection and evaluation models; the first two are written in Fortran IV and the latter two in SIMSCRIPT. All of the programs were written for the simplified version of the network approach, with indications given as to the effect of removing these simplifying assumptions. M.W.R.

N65-34512# General Electric Co., Philadelphia, Pa. Missile and Space Div.
RESEARCH STUDY OF THE BIOMEDICAL ASPECTS OF AEROSPACE SYSTEMS ENVIRONMENTAL CHAMBER MARK 1. PHASE IV: MAN RATING RESEARCH STUDY
R. A. Miller, S. W. Meyer, and R. Mader Arnold AF Station, Tenn., Arnold Eng. Develop. Center, Aug. 1965 93 p refs
(Contract AF 40(600)-1012)
(AEDC-TR-65-179, Vol. 1; AD-469038)

This report presents the results of a man rating research study on the AEDC Mark I aerospace systems environmental chamber. The purpose of the study was to determine the modifications and additions that must be performed on the chamber and its support facilities in order to permit testing of manned vehicles or shelters. Study areas were concerned mainly with establishing the support criteria, operational sequences, rescue concepts and manpower requirements that are necessary to permit continuous testing over extended time periods. Subsequent to this phase of the program, these study results were utilized as a basis for establishing detailed criteria that will permit the evolution of detail designs for the actual "man-rating" hardware. These detailed criteria are presented in a separate report. Author

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N65-33665* Texas A&M Univ., College Station.
GAS DYNAMIC STUDIES IN AN ARC-DRIVEN SHOCK TUBE
Richard E. Thomas and George Lee Huebner, Jr. *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 8 p refs (See N65-33655 22-23)
CFSTI: HC $6.00/MF $1.25

The design of an arc-driven shock tube is depicted along with a schematic diagram of the ideal wave system and flow pattern in the tube. The configuration of the tube is designed to provide an aerodynamic test facility with maximum operating range and flexibility consistent with budgetary limitations. The system will be used for studying fundamental gas kinetics and vehicle aerodynamic problems encountered in high speed flight, especially at high altitudes. The design of the driver and supporting system for the tube, and the design of the supporting structure for the facility are essentially complete. The utilization of laser and electron beam devices is being examined along with other standard instrumentation techniques for facility use. L.S.

N65-33689# ARO, Inc., Arnold Air Force Station, Tenn.
EXPANSION OF A JET INTO NEAR VACUUM Technical Report, Nov. 9–Dec. 1, 1964
R. A. Cassanova and W. B. Stephenson Arnold Eng. Develop. Center, Aug. 1965 96 p refs
(Contract AF 40(600)-1000)
(AEDC-TR-65-151; AD-469041)

The flow field of nozzles exhausting into a vacuum was investigated both analytically and experimentally. The applicability of the method of characteristics for jet expansions into a free molecular environment is discussed. Fifteen-degree, half-angle, conical nozzles with area ratios of 1.0 to 207 were tested with argon and nitrogen at total pressures of 100, 50, and 35 psia. Ambient pressures of 10^{-4} to 10^{-6} torr yielded total pressure to ambient pressure ratios of 10^{7} to 10^{9}. Properties of the flow field were determined by the use of flat plates and flow direction vanes. Author

N65-33692# Picatinny Arsenal, Dover, N. J. Feltman Research Labs.
SUPERSONIC FLOW ABOUT RIGHT CIRCULAR CONES AT ZERO YAW IN AIR AT CHEMICAL EQUILIBRIUM. PART I: CORRELATION OF FLOW PROPERTIES
Henry E. Hudgins, Jr. Aug. 1965 51 p refs
(PA-TM-1493; AD-468248)

This report presents, in the form of correlation plots and formulas, the data for the inviscid flow properties of right circular cones at zero yaw in air at chemical equilibrium. The flow properties at the cone surface or just behind the shock may be obtained directly from the correlations of this report. Methods for calculating the properties within the shock layer based on these correlations are indicated. The range for which accurate correlations of all parameters have been found is from the region of ideal gas behavior to free stream Mach numbers up to 40 and semi-cone angles up to 40°. Some correlations are valid at least as far as semi-cone angles of 50°, the limit of the data. These results apply only to attached shocks. Author

N65-33696# Tulane Univ., New Orleans, La. School of Engineering.
THE FLOW FIELD AND PERFORMANCE CHARACTERISTICS OF A MODEL BI-STABLE FLUID AMPLIFIER
H. F. Hrubecky, P. Desai, J. W. Oppenheim, and L. N. Pearce Nov. 1964 80 p refs Sponsored by the Army
(AD-465247)

The simultaneous effect of the geometric variations and mean flow condition on the switching point in a model fluid amplifier, and micromanometer and hot wire anemometer studies of the pressure and velocity variation encountered in the flow field of a model fluid amplifier are presented. A model was designed and fabricated which incorporated the following: (1) a two-dimensional mixing of two jets in a closed region with the two jets having a fully developed turbulent profile, (2) independently variable geometric boundaries, and (3) ability to

permit detailed velocity and static pressure measurements throughout the mixing region. In verifying the working of the model, a series of tests were performed to determine the effect of the geometric variables on the switching point. The detailed study encompassed a range of three flow conditions: those of no control flow, control flow to cause incipient switching, and control flow to assure switching, all for a fixed primary flow rate. C.T.C.

N65-33700*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ON THE PROBLEM OF SUSTAINED TURBULENCE

Robert G. Deissler 10 Jan. 1964 40 p refs Submitted for Publication

(NASA-TM-X-51846) CFSTI: HC $2.00/MF $0.50 CSCL 20D

Some steady-state solutions are obtained for thermal and for shear-flow turbulence by expanding two-point nonlinear correlation equations in power series in the space variables. The correlation equations, which are for inhomogeneous turbulence, are constructed from the Navier-Stokes and energy equations. To make the problem determinate, the weak-turbulence approximation is used. Steady-state solutions are possible because of the presence of nonlinear production terms in the correlation equations. Because only the low-order terms are retained in the power series used in the expansions, the solutions are accurate only for small values of the space variables, and specific boundary conditions cannot be applied. The forms of the solutions show that critical values of parameters (similar to Rayleigh or Reynolds numbers) exist below which the turbulent fluctuations are zero. The main conclusion of the study is that the Navier-Stokes and energy equations (averaged for turbulent flow) can yield solutions in which the energy fed into a turbulent field by buoyancy or shear forces is equal to that dissipated by viscosity. Author

N65-33751*# Oklahoma State Univ., Stillwater. Fluid Power Controls Lab.

STUDY OF FLUID TRANSIENTS IN CLOSED CONDUITS Interim Report No. 65-2

E. C. Fitch, J. D. Parker, C. R. Gerlach, H. C. Hewitt, G. Maples et al 18 Mar. 1965 169 p refs

(Contract NAS8-11302)

(NASA-CR-62716) CFSTI: HC $4.00/MF $1.00 CSCL 20D

A study on the effects of two-phase fluids on the characteristics of flow in fluid conduits, is presented. Progress is summarized as follows: (1) An exhaustive survey of previous investigations was completed for both single-phase and two-phase conduit systems. (2) A detailed transfer function model for a viscous, two-dimensional, single-phase conduit was derived and appears to be capable of extension to cover preliminary two-phase and cavitation studies. This model was experimentally verified for the single-phase case. (3) A conduit model showing the effects of body forces and system vibration was derived. The equipment necessary to experimentally verify this model for single-phase flow is being constructed. (4) An investigation of the nonlinear effects associated with conduit dynamics was made using a linearized second-order equation of motion. (5) The design of a hydrodynamic tunnel capable of handling liquid nitrogen was completed. (6) A bubble observation chamber, suitable for studies with liquid nitrogen, was designed and constructed. The significance of these contributions to the field of conduit dynamics and their applicability to the study of specific problems of the space program, are discussed. S.C.W.

N65-33770# California Inst. of Tech., Pasadena. Hydrodynamics Lab.

NONLINEAR GRAVITY WAVES IN A THIN SHEET OF VISCOUS FLUID

C. C. Mei Jun. 1965 35 p refs

(Contract Nonr-220(35))

(E-97.9; AD-618511)

A nonlinear theory of long gravity waves is developed for a highly viscous fluid of small depth. The expansion scheme of Lin and Clark (1959) for inviscid shallow waters is used, and discussions are then made for three different cases: $a = O(\epsilon)$, $O(\epsilon^2)$, and $O(\epsilon^3)$, where a is the dimensionless amplitude and ϵ is the dimensionless depth. In the first case a new partial differential equation is obtained which involves a nonlinear diffusion term. In the second case the governing equation is shown to be of Burgers' type. In all three cases permanent waves are treated explicitly. A variety of wave forms is found in the third case when $a = O(\epsilon^3)$: monoclinal and polyclinal waves over an inclined bottom, as well as solitary and cnoidal waves on a vertical wall. Surface tension is not considered. Author

N65-33803*# National Aeronautics and Space Administration, Washington, D. C.

METHODS OF INVESTIGATING THE DYNAMICS OF ROCKET CARRIERS AND SPACE VEHICLES [METODY ISSLEDOVANIYA DINAMIKI RAKET-NOSITELEY I KOSMICHESKIKH APPARATOV]

G. N. Mikishev May 1965 24 p Transl. into ENGLISH from Russian Presented at the 2d Ann. Conf. of the Am. Astronautical Soc., Chicago, 4–7 May 1965

(NASA-TT-F-9544) CFSTI: HC $1.00/MF $0.50 CSCL 20D

The dynamics of rocket carriers and Space vehicles is investigated on the example of an absolutely rigid body having cavities partially filled with liquid, to take disturbed motion produced by propellant sloshing into consideration. Theoretical and experimental methods for determining the hydraulic factors for cavities of various shapes (cylindrical, spherical, conical, and toroidal) are discussed, with a comparative analysis of the results and instructions for programing the data on digital computers. The stabilization problem is solved on an analog computer, feeding the dynamic properties of cylindrical cavities over a mechanical model and writing the equations of disturbed motion into the computer. Author

N65-33837*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF EXHAUST BACKFLOW FROM A SIMULATED CLUSTER OF THREE WIDE-SPACE ROCKET NOZZLES IN A NEAR-SPACE ENVIRONMENT

James M. Cubbage Washington, NASA, Sep. 1965 59 p refs

(NASA-TN-D-3016) CFSTI: HC $3.00/MF $0.50 CSCL 01A

A limited experimental investigation has been conducted to confirm the existence of exhaust backflow from a cluster of three widely spaced nozzles operating in a near-space environment and to determine pressures and heat-transfer coefficients in the region washed by the backflow. Experiments were conducted in a 61-foot-diameter vacuum sphere using a single solid-propellant rocket motor and a reflection plate. The reflection plate was used to simulate the interference planes that would normally exist for a cluster of three nozzles. Data were obtained for nozzle spacings of 8.02 and 17.15 nozzle exit diameters for pressures which simulated a nominal altitude range of 3.2×10^5 to 1.8×10^5 feet. The pressure data indicated that the backflow was supersonic for several nozzle exit diameters ahead (upstream) of the nozzle exit plane and that the flow over small-diameter

thermocouples in this region was in the free-molecule region. Average heat-transfer coefficients obtained for small-diameter cylinders (thermocouples) in this region were on the order of 1×10^{-4} Btu/sq ft-sec-° R. Author

N65-33840*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
UNSTEADY VISCOUS VORTEX WITH FLOW TOWARD THE CENTER
Robert G. Deissler Washington, NASA, Sep. 1965 18 p refs
(NASA-TN-D-3026) CFSTI: HC $1.00/MF $0.50 CSCL 20D

An analysis was made of a strong unsteady vortex that consists of an annular region, in which the flow is tangential and radial, and a core region, in which a uniform axial flow is also present. The effects of end-wall boundary layers, if present and important, were assumed to be eliminated by use of suitably rotating end walls. The Navier–Stokes equation for the tangential flow was solved numerically to carry out the analysis. Step changes in the tangential velocity at a given radius and step changes in the radial flow are introduced for various initial tangential velocity profiles. The response of the tangential flow is then calculated as a function of radius and of time. Author

N65-33866*# Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering.
COLLAPSE OF A CAVITATION BUBBLE IN VISCOUS COMPRESSIBLE LIQUID– NUMERICAL AND EXPERIMENTAL ANALYSES Technical Report No. 15
Richard D. Ivany (Ph.D. Thesis) Apr. 1965 219 p refs
(Grants NsG-39-60; NSF G-22529)
(NASA-CR-64998) CFSTI: HC $6.00/MF $1.25 CSCL 20D

The behavior of the interface after the bubble is formed and starts to collapse, and the behavior of the liquid adjacent to the interface are the main consideration. Hydrodynamic equations are derived and incorporate the following: equations of flow and the Rayleigh solution, incompressible liquid with surface tension and viscosity, compressible viscous liquid, and surface tension and viscosity effects in bubble collapse. Numerical analyses include behavior of characteristic curves, pressure and velocity fields in the liquid during bubble collapse, bubble collapse with adiabatic internal gas compression, bubble wall velocity with various parameters, and pressure pulse from a rebounding bubble. The experimental equipment is described, and the results of tests are given. Conclusions are presented and incorporate the effects of viscosity, surface tension, compressibility, and damage mechanisms. C.T.C.

N65-33867*# General Applied Science Labs., Inc., Westbury, N. Y. Research Dept.
SLOT INJECTION OF REACTIVE GASES IN LAMINAR FLOW WITH APPLICATION TO HYDROGEN DUMPING Technical Report 332
Paul A. Taub 2 Jan. 1962 63 p refs
(Contract NAS8-2686)
(NASA-CR-64999) CFSTI: HC $3.00/MF $0.75 CSCL 01A

The slot injection of reactive gases into a high speed airstream has been investigated. The chemical and transport properties have been simplified and calculations have been carried out for the case of a prescribed constant wall temperature. Computations for hydrogen injection into an airstream flowing over a flat plate are presented and compared with the related, but more restricted theory of Libby and Schetz. Results illustrate the advantages of injecting cold gases into the boundary layers of launch vehicles. In many cases, reactions may be assumed to occur; then, it is seen that the heat transfer rise associated with combustion may be delayed for substantial distances downstream from a slot injector and occurs in a region of relatively low heat transfer. Author

N65-33890# Israel Inst. of Technology, Haifa. Dept. of Aeronautical Engineering.
NEAR WAKE FLOW STUDIES IN SUPERSONIC FLOW Annual Summary Report No. 3
Josef Rom Mar. 1965 62 p refs
(Contract AF 61(052)-576)
(TAE-38; AD-617943) CFSTI: HC $3.00/MF $0.75

The theoretical and experimental investigations carried out on supersonic flow over two-dimensional and axially symmetric base type separated flows are summarized in this report. Correlating equations for base pressure and backward facing step pressure with laminar and turbulent separation are presented. These relations are obtained from considerations of the analysis based on the integral method and experimental data. Measurements of total pressure and temperature profiles in the near wake of a two-dimensional wedge-flat plate model at M = 3.5 indicate high recovery temperatures at the outer regions of the wake beyond the "neck" position. The development of the shock tunnel and its associated equipment is reported, including an improved method for thin film resistance thermometers calibration. Author

N65-33893# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
EXPERIMENTAL INVESTIGATION OF THE INTERACTION OF A SHOCK WAVE AND AN ELECTRIC ARC
William Spencer Campbell Mar. 1965 55 p refs
(GSP/PH/65-5; AD-617949)

A shock tube was assembled and instrumented to study a shock propagating along the interelectrode axis of an electric arc. Shock tube calculations were presented and compared with experimental data. Mach numbers were generally predicted within seven percent. A graphical means of determining diaphragm score depths for given bursting pressures was displayed. An experimental model of the arc as an axi-symmetric, homogenous plasma was used to relate the results of various investigations in gas dynamics to the shock-arc interaction. Shadowgraph pictures were attempted, but results were negative. Equations for the method of characteristics were developed in the appendix. Author

N65-33911# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AN EXPERIMENTAL INVESTIGATION OF FLUID FLOW THROUGH SQUARE EDGED ORIFICES LOCATED IN A ROTATING DISK
Clark David Carlen (M.S. Thesis) Mar. 1965 64 p refs
(GAM-65A/ME/65-2; AD-618098)

Previous investigators have shown that the discharge coefficient of circular orifices may be markedly reduced if located in a rotating disk. This thesis confirms the fact that orifice velocity and the pressure differential across the rotating disk are parameters affecting the discharge coefficient. In addition, fluid (air) density and orifice configuration were found to have a large effect on the discharge coefficient of rotating orifices. Disk thickness was not found to have an appreciable effect. The explanation for these effects is that the fluid enters the rotating orifice at an angle, which in turn decreases the orifice jet area. Author

N65-33960*# National Aeronautics and Space Administration. Washington, D. C.
SELF-SIMILAR MOTION OF FLUID UNDER THE ACTION OF SURFACE TENSION

F. L. Chernous'ko Sep. 1965 16 p refs Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), v. 19, 1965 p 54–61
(NASA-TT-F-9561) CFSTI: HC $1.00/MF $0.50 CSCL 20D

Investigation of the behavior of a weightless fluid with a free surface set in motion from a state of rest by the force of surface tension. A particular case of the problem of self-similarity is formulated and solved. Author

N65-33968*# Israel Program for Scientific Translations, Ltd., Jerusalem.

APPLIED FLUID DYNAMICS

I. P. Ginzburg 1963 264 p refs Transl. into ENGLISH of the book "Prikladnaya Gidrogazodinamika" Leningrad, Izd. Leningradskogo Universiteta, 1958 Published for NASA and NSF
(NASA-TT-F-94) CFSTI: HC $2.75/MF $1.50 CSCL 20D

Some of the problems of fluid mechanics which are frequently met in the engineering design of various machine assemblies and engineering installations are discussed. The steady and unsteady flow of liquids and gases in pipes are examined and associated problems are considered. Theoretical calculations are illustrated by means of practical examples. Some new methods of solution of the problems of gas flow through pipes, of gas efflux from vessels, of water hammer, and others, are also given. The book is based on a lecture course in applied fluid dynamics given for many years at Leningrad State University. E.E.B.

N65-33983# Douglas Aircraft Co., Inc., Long Beach, Calif. Aircraft Div.

A GENERAL THEORY OF STABILITY OF THE MOTION OF A FLUID WITH HEAT TRANSPORT AND ARBITRARY FORCE FIELDS

Richard L. Moore 19 Jan. 1965 61 p refs Revised *Its* Paper No. 3406

The equations of a fluid with non-uniform density and heat addition are reduced without approximation from six equations in six unknowns (by eliminating the density and pressure) to obtain four equations in the four unknowns: the temperature field and the three components of the velocity field. Conditions are obtained for the stability of a dissipationless cylindrical plasma with a gaussian radial density distribution. The vector wave equation which derived is applied to: (a) MHD waves, (b) electron oscillations in a uniform magnetic field, (c) waves in stratified fluids, and (d) the stability of Poiseuille flow. Agreement with the standard results are found for (a), (b), and (c). A theorem on the mechanism for the generation of waves in (c) is obtained. The Orr-Sommerfeld equation is found to be inapplicable for the Poiseuille flow of a fluid with an equation of state, and a more general equation is obtained. Author

N65-34041# Space Technology Labs., Inc., Redondo Beach, Calif.

CHARACTERISTICS SOLUTION FOR NONEQUILIBRIUM FLOW FIELDS ABOUT AXISYMMETRIC BODIES. VOLUME I: RESULTS AND ANALYSIS

James R. Kliegel, Robert L. Peters, and J. T. Lee, Jr. Jul. 1964 100 p refs
(Contract AF 04(694)-440)
(STL-6453-6001-KU-000; AD-464623)

Exact numerical solutions for the inviscid nonequilibrium reacting gas flow about axisymmetric bodies have been obtained using the method of characteristics. Volume I of this report describes the numerical analysis and presents sample results for pointed bodies in the earth's atmosphere at an altitutde of 200,000 feet and velocity of 22,000 ft/sec. The results presented assume vibrational equilibrium with no charged species. Volume II describes in detail the computer program that has been developed for calculating various types of flow fields. Author

N65-34055# Princeton Univ., N. J. Gas Dynamics Lab.

ON A NEW ULTRA-HIGH VACUUM PUMP

Yau Wu Dec. 1964 16 p refs *Its* Rept.-715
(Contract AF 49(638)-1271; Grant NSF GP-59)
(AFOSR-65-0194; AD-615149)

The theory of highly rarefied cascade flow has been presented and a proposal for a new axial-flow (or radial flow) pump (or compressor) in the free-molecule range has been made. An unconventional cascade has been suggested which will produce an extremely high compression ratio (up to 30,000) in a single stage at very high blade speed ($S = V_b/\sqrt{2\,RT} \simeq 20$). This new pump (or compressor) can be used to reach any ultra-high vacuum state, i.e., an "almost empty state" Author

N65-34109# Manchester Univ. (England). Dept. of Mechanics of Fluids.

RAREFIED GAS FLOWS BY MONTE CARLO METHODS AND UNSTEADY GAS FLOWS IN GRAVITATIONAL FIELDS Final Report

G. A. Bird 15 Mar. 1965 8 p refs
(Grant AF-EOAR-64-65)
(AFOSR-65-1013; AD-618309)

Methods were developed for conducting "numerical experiments" with a model gas in a digital computer. The methods were used to investigate the structure of strong normal shock waves, and the aerodynamic properties of simple bodies in the hypersonic transition regime. The quasi-steady equilibrium state of a shock-heated atmosphere was studied with particular reference to the solar atmosphere. A method was also developed for the study of the unsteady behaviour of a heated atmosphere. Author

N65-34116# California Univ., Livermore. Lawrence Radiation Lab.

DERIVATION OF A GENERALIZED VON NEUMANN PSEUDO-VISCOSITY WITH DIRECTIONAL PROPERTIES

Gerald T. Richards 21 Jul. 1965 22 p refs
(Contract W-7405-ENG-48)
(UCRL-14244)

An absolute scalar pseudo-viscosity ("q") expression for handling shocks automatically in numerical calculations of three-dimensional fluid dynamics problems is derived. The expression is a generalization of that derived by von Neumann and Richtmyer in the sense that the expressions are identical for a plane shock wave. The basic assumption made is that a shock will be formed in a material when there is compression in the direction of acceleration; this assumption seems "reasonable" physically, since this condition indicates that a grid established about a point with such compression will collapse, i.e., the "rear" of the grid will overtake the "front." The expression "q" is derived for a generalized curvilinear coordinate space and the expression is given for the three commonly used coordinate systems. The expression is also written for the plane rectangular case and the cylindrical case with no angular motion to be used in connection with the HEMP code. Author

N65-34119# Pennsylvania State Univ., University Park. Ordnance Research Lab.

UNSTEADY PROPELLER FORCES

L. M. Casselini 30 Jun. 1965 74 p refs
(Contract NOw-65-0123-d)
(TM-504.2461-06; AD-618486)

The problem of unsteady forces on a propeller operating in a nonuniform inflow and subjected to homogeneous, isotropic turbulence has been analyzed. Methods are presented for calculating the magnitude of the unsteady forces from these two causes. The theory is applied to a free-stream propeller operating in the wake of a single strut and in a turbulent flow. The calculations include variations of strut-to-propeller spacing, number of blades and blade sweep and show how unsteady forces are affected. In the case of a turbulent inflow, force spectra and the unsteady thrust coefficient are calculated. These quantities are seen to depend on two ratios: the characteristic eddy size divided by the propeller diameter, and the characteristic eddy size divided by the propeller blade chord length. It is shown that the unsteady forces due to turbulence are of the same order of magnitude as those due to a nonuniform inflow. Author

N65-34143# Naval Ordnance Lab., White Oak, Md. Air/Ground Explosions Div.

THEORETICAL VERSUS EXPERIMENTAL RESULTS FOR AIR BLAST FROM ONE-POUND SPHERICAL TNT AND PENTOLITE CHARGES AT SEA LEVEL CONDITIONS

Morton Lutzky Sep. 1965 32 p refs

(NOLTR-65-57; AD-619438)

Numerical computations, using a one-dimensional hydrodynamic code on an IBM 7090, have been made for the detonation of 1-lb spheres of pentolite and TNT at sea level. Positive durations, overpressure at the main shock, and space-time paths of the main shock, second shock, and contact surface are compared with experimental data. It is found that the calculated peak pressures at the main shock are 10 percent too low, the experimental second shock path lies about 40 percent above the calculated one, and the experimental contact surface path is about a factor of two greater in radius than the calculated one. Possible explanations for these deviations are discussed. Author

N65-34144# Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.

PERFORMANCE OF SUPERCAVITATING HYDROFOILS WITH FLAPS, WITH SPECIAL REFERENCE TO LEAKAGE AND OPTIMIZATION OF FLAP DESIGN

R. Oba May 1965 42 p refs *Its* Tech. Paper No. 51, Ser. B

(Contract Nonr-710(24))

(AD-619516)

A modified linearized theory was developed for supercavitating, flapped foils of arbitrary form in which effects of fluid leakage through the flap hinge were considered. It was found that the performance at conditions other than design conditions was improved with the use of trailing edge flaps. The drag-lift ratio may be reduced by a factor of 1/2 to 1/3. The foil performance is dependent on the flap-chord ratio, e, and the flap deflection, performance increasing with small e. Effects produced by leakage through the flap hinge were significant in their influence on velocity distribution and flap effectiveness (increment in lift coefficent per unit change in flap angle). The effect of hinge leakage on the overall performance, i.e., lift, drag, and moment, was small and may be neglected in most cases. Author

N65-34146# Naval Ordnance Lab., White Oak, Md.

THE PRESENTATION OF THE PROPELLANT FLOW IN A CONSTANT ACCELERATION GUN BY THE METHOD OF CHARACTERISTICS

Ernst H. Winkler Sep. 1965 34 p refs *Its* Ballistics Res. Rept. 128

(Ballistics Res. Rept.-128; NOLTR-64-69; AD-619865)

The propellant flow in a constant acceleration gas gun has been presented by the method of characteristics. The presentation has been done in Eulerian as well as Lagrangian coordinates. To illustrate the properties of constant acceleration flows and to facilitate the investigation by the method of characteristics a simple means of generating the flow has been examined in more detail. The equations describing constant acceleration flows have been reviewed and extended. Author

N65-34188# Naval Weapons Lab., Dahlgren, Va. Computation and Analysis Lab.

COMPUTING PROGRAMS FOR SURFACE WAVE TRAINS OF POINT SOURCES

A. V. Hershey 30 Jun. 1965 29 p refs

(NWL-1987; AD-619648)

Descriptions are given for four programs which compute the components of velocity in the wave train of a unit source. The programs give the velocity at an arbitrary position in any direction and at any distance from the source. The programs have been used to compute a table of components of velocity for 27 000 positions. Author

N65-34209# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.

APPLYING THE METHOD OF CHARACTERISTICS TO ANALYZE THE FLOW FIELD OF A CHEMICALLY REACTING GAS IN A TWO-DIMENSIONAL OR AN AXISYMMETRIC NOZZLE

Roger R. Craig Apr. 1965 40 p refs

(AFAPL-TR-65-20; AD-618068)

A computer program was written for the chemical system $N_2O_4 + N_2 \rightleftarrows 2NO_2 + N_2$. The program applies the numerical solution of the method of characteristics to finite rate chemical reactions. The mathematics used, the difficulties encountered, and solutions in the development of the program for the two-dimensional and axisymmetric fields of the supersonic stream in which the reaction is occurring are discussed. Excellent agreement was obtained between the computed flow properties and experimental data for the system. In addition, computer data for a hydrogen-air system was in good agreement with experimental data. L.S.

N65-34268# AVCO-Everett Research Lab., Everett, Mass.

EXCITATION STUDIES ON THE N_2 (1+) AND N_2 (1−) SYSTEMS IN SHOCK-HEATED N–N_2 MIXTURES

Kurt L. Wray Aug. 1965 35 p refs Submitted for Publication

(Contract DA-01-021-AMC-12005(Z))

(AVCO Everett Res. Rept.-220; AD-469638)

The rate of excitation of the $N_2(1+)$ and $N_2(1-)$ band systems was observed in shock-heated N–N_2 mixtures in which the initial mixture ratio N/N_2 ranged from 0 to 0.27. A pulsed discharge prior to diaphragm rupture produced the N-atoms; their concentration was determined by monitoring the decay of the Lewis-Rayleigh afterglow for about 50 msec subsequent to the discharge and up to the arrival of the shock. The shock waves produced temperatures in the range 7000–18,600° K close to the shock front, after rotational relaxation. The radiation intensities from the $N_2(1+)$ (6600 to 8000A) and $N_2(1-)$ (0,1) (4272 Å) bands were monitored as functions of time behind the shock front. The initial slopes of the radiation time histories were compared with theoretical slopes. The rate constant expression for exciting ground state nitrogen $X^1\Sigma_g$ to the $A^3\Sigma^+$ state by collisions with N-atoms was found to be $k_N = 1.9 \times 10^{-8} T^{-3/2} \exp(-E_{XA}/kT)$ cm^3/particle-sec, where $E_{XA} = 6.168$ eV. This yields an effective cross section of 2.7×10^{-18} cm^2

at 12,000° K. The analogous rate constant for collisions with N_2 was determined to be $k_{N_2} \leq 0.001\ k_N$. Author

N65-34269# Hydronautics, Inc., Laurel, Md.
THE EFFECT OF EJECTED POLYMER SOLUTIONS ON THE RESISTANCE AND WAKE OF A FLAT PLATE IN A WATER FLOW
Richard H. Love Jun. 1965 95 p refs
(Contract Nonr-4181(00))
(TR-353-2; AD-468253)

An experimental investigation was made into the effects of injecting non-Newtonian fluids into the turbulent boundary layer of a flat plate. The ejection of weakly viscoelastic solutions of a macromolecular polymer at the leading edge of the plate decreased its darg coefficient by as much as 50 percent; the Reynolds number of the plate was 1.8×10^6. It was found that for a given ejection rate and free stream velocity there was a solution concentration for which the drag coefficient was a minimum. It is conjectured that the relatively sharp loss of effectiveness for higher concentrations may be due to insufficient mixing of the additive into the turbulent boundary layer. Ejection of neutrally buoyant spherical particles, not too much larger than the macromolecules, had no effect on the drag of the plate, indicating that the drag reduction is probably associated with the viscoelastic properties of the solutions studied. Author

N65-34293# Stevens Inst. of Tech., Hoboken, N. J. Davidson Lab.
LATERAL FORCE AND MOMENT ON OSCILLATING THIN SHIPS WITH FORWARD SPEED
Pung Nien Hu Jun. 1965 44 p refs
(Contract Nonr-263(24))
(Rept.-1058; AD-468589)

A method for the evaluation of lateral hydrodynamic force and moment acting on oscillating thin ships with forward speed in calm water is developed, in terms of the lateral hydrodynamical coefficients (i.e., added masses, damping coefficients, dynamic coupling terms, and stability derivatives). An asymptotic expression of Green's function is used to formulate an integral equation for doublet distributions which is then solved by perturbation technique. General expressions for the zero- and first-order solutions of the hydrodynamical coefficients are obtained and results are discussed. Author

N65-34312# Los Alamos Scientific Lab., N. Mex.
THE TRANSITION BETWEEN LAMINAR AND TURBULENT FLOW OF GASES IN A SMOOTH ROUND TUBE [DER UBERGANG ZWISCHEN LAMINAR UND TURBULENTER STROMUNG VON GASEN IN EINEM KREISZYLINDRISCHEN, GLATTEN ROHR]
H. Mache [1965] 9 p Transl. into ENGLISH from Forsch. Gebiete Ingenieurw. (Germany), v. 14, May–Jun. 1943 p 77–81
(LA-TR-65-11)

The transition region between laminar and turbulent gas flow in a smooth, round tube was investigated. Air with an additive of propane was guided through a perpendicular standing tube and ignited at the upper end of the tube. In the case of laminar flow a quiet conical burning surface formed, and in the case of turbulent flow a flickering flame with a torn burning surface was observed. Between lies a transition region in which the flow goes from a pure laminar to a pure turbulent form. Schlieren photographs of the flame structure together with measurements of the average viscosity of the air-propane mixture were used to plot the length and breadth of the transition region as a function of time and of the entering conditions of the flow into the tube. It was concluded that the transition zone is not sharply bounded below; boundary values depended on the inlet configuration and the tube dimensions. It was also observed that a gas jet exhausting out of the tube is enclosed by a laminar flowing mantle. G.G.

N65-34325# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
REACTION RATE COEFFICIENTS FOR NEUTRAL SPECIES IN PROPELLANT GASES
C. Baulknight Apr. 1965 22 p refs
(RM-274)

The chemical kinetics of the mutual interaction of neutral gas species in propellant gases are discussed in this memorandum. The equilibrium compositions of typical rocket propellants are given; from these the most probable reactions are deduced and the reaction rate coefficients are estimated. Available theoretical and experimental data have been utilized in the formulation of the rate coefficients appropriate to the temperature range and composition of the system. In nozzle expansion processes the most important kinetics involved are those of the three-body recombination type. Although the third body's concentration remains unchanged, the rate constants are given in accordance with third order chemical kinetics despite the fact that these reactions are kinetically of second order. There are other types of recombination and ionization processes occurring in the system under investigation, but they will not be discussed in this memorandum. Investigations of these phenomena are currently under way and the results will be reported later. Author

N65-34413*# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
RESEARCH IN GAS-SURFACE INTERACTION, 1964–65. PART III: SURFACE CONTAMINATION Final Report
Calvin H. Weiser Aug. 1965 16 p refs
(Contract NASw-1027)
(NASA-CR-67155; RE-224) CFSTI: HC $1.00/MF $0.50 CSCL 13H

Preliminary experience on the performance of the surface preparation and characterization apparatus is described. The vacuum system is being modified to increase its reliability and ease of performance. The electrooptical experiments that have been performed indicate that the techniques and equipment to be used will be adequate. In the very near future we expect to begin our major effort toward performing the necessary experiments leading to useful surface preparation techniques. Author

N65-34504*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SEMIEMPIRICAL METHOD FOR PREDICTING EFFECTS OF INCIDENT-REFLECTING SHOCKS ON THE TURBULENT BOUNDARY LAYER
S. Z. Pinckney Washington, NASA, Oct. 1965 101 p refs
(NASA-TN-D-3029) CFSTI: HC $3.00/MF $0.75 CSCL 20D

A method is presented for the calculation of the boundary layer velocity profile change and various thickness parameter changes across a two-dimensional incident-reflecting shock. The method employs a one-dimensional hypothetical flow, representative of the boundary layer, in conjunction with a postulated boundary layer shock model. Curves, calculated by using the method, are presented for boundary layer velocity profile, boundary layer thickness, momentum thickness and displacement thickness changes across an incident

reflecting shock for a Mach number range from 2 to 6, a Reynolds number range based on an equivalent length from 3.3×10^5 to $3.3 \times 1f110^7$, and incident shock-turning angle range from 0° to 12°. Curves are also presented (empirically determined) for important incident reflecting shock–boundary layer interaction lengths. An outline of a procedure which can be followed in the practical application of the method is also included. Comparison of the calculated velocity profile change (measured through the profile index change) and boundary layer thickness change with experimental data gave good agreement. Author

N65-34513# Pennsylvania State Univ., University Park. Dept. of Mechanical Engineering.
FURTHER STUDIES OF THE CURVED TURBULENT MIXING LAYER Final Report
David Margolis Sep. 1965 109 p refs
(Contract DA-31-124-ARO(D)-153)
(AD-470346)

A systematic theoretical and experimental investigation of a curved turbulent mixing layer is presented. The single-point triple velocity correlations, the spectra of the triple correlations, and the shear spectra were measured for the unstable case. The probability density function of the streamwise velocity component and the probability density function of the derivative of the streamwise velocity component were also measured throughout the flow field. C.T.C.

N65-34635# Advisory Group for Aeronautical Research and Development, Paris (France).
RECENT DEVELOPMENTS IN BOUNDARY LAYER RESEARCH, PART I
May 1965 561 p refs Proc. of a Specialists' Meeting, AGARD Fluid Dyn. Panel, Naples, 10–14 May 1965
(AGARDograph-97, Pt. I)

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9. THE MEAN FLOW IN THE OUTER REGION OF TURBULENT BOUNDARY LAYERS T. N. Stevenson (Manchester Univ.) p 281–314 refs (See N65-34644 22-12)

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15. TRANSITION REVERSAL ON A FLAT PLATE AT HYPERSONIC SPEEDS B. E. Richards and J. L. Stollery (Imperial Coll. of Science & Tech.) p 477–501 refs (See N65-34650 22-12)

16. BOUNDARY-LAYER DISTURBANCE BY ISOLATED PROTUBERANCES OF VARIABLE HEIGHT ON A CYLINDER NOSE E. Dobbinga (Technische Hogeschool) p 503–521 refs (See N65-34651 22-01)

17. SOME PROBLEMS OF FLOW LAMINARIZATION ON A SLENDER DELTA WING N. Gregory and E. M. Love (Ntl. Phy. Lab.) p 523–566 refs (See N65-34652 22-01)

N65-34636 Martin Co., Baltimore, Md.
THE THREE-DIMENSIONAL STRUCTURE OF THE VISCOUS SUBLAYER
J. Sternberg *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 1–33 refs (See N65-34635 22-12)

A simplified form of a theory for the fluctuations in the viscous sublayer of a turbulent flow was given in a previous paper by the author. In this paper, the analysis is extended to include additional terms in the equations representing the convective effect of the mean flow on the fluctuation field. This makes it possible to obtain solutions for the elementary Fourier components at different wave numbers at all angles of obliquity to the flow direction. It is found that there is a strong effect of obliquity on the structure of the elementary components. Comparisons with available experimental data indicate that the energy-containing disturbances are strongly aligned with the flow direction. Author

N65-34638 France. Office Nationale d'Etudes et de Recherches Aeronautiques, Chatillon-Sous-Bagneux.
SOME RESULTS OF THERMAL CHARACTERISTICS OF TURBULENT BOUNDARY LAYERS AT HIGH TEMPERATURE [QUELQUES RESULTATS SUR LES CARACTERISTIQUES THERMIQUES DES COUCHES LIMITES TURBULENTES A TEMPERATURE ELEVEE]
R. Michel and P. Mentre *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 65–95 refs In FRENCH; ENGLISH summary (See N65-34635 22-12)

This paper is devoted to the analysis of turbulent boundary-layers at temperatures sufficiently high for dissociation to occur. In the first part the enthalpy distributions and the concentration in a flat plate boundary-layer are studied by

means of a combination of the local boundary-layer equations in the cases of the perfect gas and of the real gas either frozen or at equilibrium. The ratio of the heat flux to the wall friction is thus deduced. The results obtained are used in the second part to calculate the heat transfer on rounded fore-bodies by integration of the global energy equation. Author

N65-34639 Royal Aircraft Establishment, Bedford (England).
MEASUREMENTS OF TURBULENT SKIN FRICTION AT HIGH REYNOLDS NUMBERS AT MACH NUMBERS OF 0.2 AND 2.2
K. G. Winter, K. G. Smith, and L. Gaudet *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 97–123 refs (See N65-34635 22-12)

The measurements, taken on the sidewall of the R.A.E. 8ft × 8 ft Wind Tunnel, consist of surface shearing stress using a large force balance together with velocity and temperature distributions through the boundary layer. The maximum effective length Reynolds numbers obtained are 2.2×10^8 at $M = 0.2$ and 1.1×10^8 at $M = 2.2$. The results agree moderately well with the empirical correlation proposed by Spalding and Chi. The variation of skin friction with Reynolds number is however less than given by most of the accepted formulae. Author

N65-34640 Von Karman Inst. for Fluid Dynamics, Rhode Saint-Gènese (Belgium).
THE TURBULENT WALL JET IN A MOVING STREAM
G. L. Harris *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 125–158 refs (See N65-34635 22-12)

The two-dimensional incompressible turbulent wall jet on a plane surface beneath a moving stream of arbitrary pressure gradient has been treated analytically by integral methods. The solution has been programmed for the IBM 1620 digital computer and the results thereby obtained compared with experimental data. Author

N65-34641 Cambridge Univ. (England). Engineering Lab.
THE CALCULATION OF SHAPE-FACTOR DEVELOPMENT IN INCOMPRESSIBLE TURBULENT BOUNDARY LAYERS WITH OR WITHOUT TRANSPIRATION
B. G. J. Thompson *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 159–190 refs (See N65-34635 22-12)

The predictions of shape-factor development given by existing auxiliary equations are shown to vary widely and are in some cases very inaccurate. Head's entrainment equation is the most generally satisfactory. A new entrainment equation is described and is shown to give improved agreement with experiment, especially in equilibrium conditions. An important feature of this new approach is the use of an explicit term to account for the effects of small three-dimensional flows that appear to be present in measured layers, as indicated by the disagreement between measured growth of momentum thickness and the predictions of the two-dimensional momentum equation even far from separation. Finally, the entrainment methods are shown to be distinctly superior, in conditions of distributed suction of blowing, to the method of Pechau. Author

N65-34642 Imperial Coll. of Science and Technology, London (England).
THE KINETIC-ENERGY-DEFICIT EQUATION OF THE TURBULENT BOUNDARY LAYER
D. B. Spalding *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 191–244 refs (See N65-34635 22-12)

It is shown that formal relations exist between the "entrainment function" appearing in the theory of Head (1960) and others, and the "dissipation integral" appearing in the theories of Rotta (1950), Truckenbrodt (1951) and others. Use of the relations, and of knowledge of free turbulent flows, permits improved expressions to be recommended for the dissipation integral, valid for near-flat-plate flows, for nearly-separating boundary layers, and for flows for which the velocity profiles exhibit maxima. The relations also indicate a non-arbitrary definition of the outer "edge" of the boundary layer for use with the entrainment function. Further research will be needed to verify and improve the recommendations which have been made to extend them to situations of greater complexity; some suggestions are made concerning these extensions. Author

N65-34643 National Physical Lab., Teddington (England).
TURBULENT-BOUNDARY-LAYER BEHAVIOUR AND THE AUXILIARY EQUATION
John F. Nash *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 245–279 refs (See N65-34635 22-12)

In addition to the Kármán momentum-integral equation, two further equations are required for the purposes of calculating the development of the incompressible turbulent boundary layer–a "skin-friction law" and an "auxiliary equation". The problem of deriving a satisfactory form of auxiliary equation is a major one. Indeed, despite the effort devoted to this equation for many years, few derived forms of auxiliary equation can be relied upon to account for the boundary-layer development in more than a restricted number of cases. As a contribution to the elucidation of the problem an examination is made of several sets of experimental data covering different types of pressure distribution. Among the data certain basic types of boundary-layer behaviour can be distinguished. The equilibrium boundary-layer may be regarded as a datum condition and the other types of behaviour are discussed in the context of tendencies towards, or departures from equilibrium. Simple forms of auxiliary equation are postulated and an examination is made of the extent to which they can be reconciled, even qualitatively, with the observed types of boundary-layer behaviour. Author

N65-34644 Manchester Univ. (England).
THE MEAN FLOW IN THE OUTER REGION OF TURBULENT BOUNDARY LAYERS
T. Neil Stevenson *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 281–314 refs (See N65-34635 22-12)

A dimensional analysis is used to indicate the equation for the mean velocity distribution in the outer region of incompressible turbulent boundary layers in terms of a function, F. In the intermediate region this function which occurs in boundary layers in small pressure gradients, at separation and with transpiration is the same as that in zero pressure gradient flow. Experiments in boundary layers in zero pressure gradient, with injection and at separation show that F is virtually a function of y/δ only. The similarity flow in which F is a function of y/δ only is then considered for boundary layers in small pressure gradients. The calculations involve the functions and constants which occur in zero pressure gradient flow, but no other experimentally determined constants or functions are used. The theoretical total shear stress variations across boundary layers with injection and at separation are consistent with measured distributions. Author

N65-34645 Technische Hogeschool, Delft (Netherlands). Dept. of Aeronautical Engineering.
THE TURBULENT ASYMPTOTIC LAYER
H. Tennekes *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 315–327 refs (See N65-34635 22-12)

Some properties of turbulent asymptotic layers in zero pressure gradient with uniform suction, which are equilibrium layers in the sense defined by Clauser, are discussed. A provisional skin friction law for asymptotic layers is given. It is shown that mixing length theory is unable to account for the similarity of the experimental data. The assumption of a constant eddy viscosity in the outer part of asymptotic layer leads to a fair representation of the experimental data. The magnitude of the eddy viscosity of asymptotic layers is only one fifth of the eddy viscosity of turbulent boundary layers on impervious walls. Author

N65-34646 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE STABILITY OF THE COMPRESSIBLE LAMINAR BOUNDARY LAYER ACCORDING TO A DIRECT NUMERICAL SOLUTION
L. M. Mack *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 329–362 refs (See N65-34635 22-12)
(Contract NAS7-100)

Two direct numerical methods are used to obtain eigenvalues and eigenfunctions of the complete linearized stability equations and of the inviscid stability equations. For the inviscid equations, new families of amplified solutions are found. The maximum amplification rates and frequencies of these solutions are computed as functions of M_1, the free-stream Mach number, and as functions of wall temperature (cooled wall only) at $M_1 = 5.8$. It is found that one of the new families of solutions is the most unstable and is destabilized by cooling. For finite Reynolds numbers, neutral stability curves are computed, and at a fixed Reynolds number the maximum amplification of disturbances of constant frequency is computed as a function of M_1 and of the wall temperature at $M_1 = 5.8$. The maximum amplification decreases with increasing M_1 at low supersonic Mach numbers, rises to a peak near $M_1 = 5$, and then decreases with further increases in M_1. Cooling the wall is found to have little effect on the maximum amplification. Author

N65-34647 Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
THE EFFECT OF COMPLAINT WALLS ON BOUNDARY LAYER STABILITY AND TRANSITION
Marten T. Landahl and Richard E. Kaplan *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 363–394 refs Prepared jointly with Univ. of Southern Calif. (See N65-34635 22-12)
(Contract Nonr-1841(89))

Recent theoretical progress in the field of boundary layer stability and transition as influenced by a complaint surface is reviewed. The main physical mechanisms involved in boundary layer instability are explained, and it is demonstrated that for any stabilization method to be effective the net dissipation associated with an instability wave must be reduced. Results of extensive numerical calculations show that for certain combinations of compliant surface parameters it is possible to reduce the spatial amplification rates substantially, although the increase in critical Reynolds number usually is small. The main practical difficulty associated with this method of boundary layer stabilization is to find a compliant surface material of low mass density. The qualitative effects of a wall flexibility on the later non-linear stages of transition are also discussed. It is concluded that the direct effect on the non-linear breakdown process is likely to be small and that the main effect is on the primary wave whose nature may be altered and thus the condition for the appearance of turbulent bursts. Author

N65-34648 Brussels Univ. (Belgium).
STREAMWISE VORTICES IN LAMINAR FLOW
Jean J. Ginoux *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 395–422 refs Prepared jointly with von Karman Inst. for Fluid Dyn. (See N65-34635 22-21)

It is now generally accepted that one stage of the laminar-turbulent transition process, which followed the region of growing Tollmien-Schlichting waves, is one of developing transverse variations in the boundary layer velocity and wave intensity. These transverse variations are systematically observed by the author in reattaching supersonic and hypersonic flows, with a wavelength which was a function of the boundary layer thickness and of a characteristic length of the separated zone. They were also observed on supersonic swept back wings. Refined measurements made at supersonic speeds with small pitot-static probes showed that these variations were caused by one or two rows of counter-rotating streamwise vortices located generally inside the reattaching boundary layers. Very local heat transfer measurements showed that large transverse variations of heat rates existed because of these vortices. Although the mean value of the Stanton number was very near the turbulent value, its local value could be much higher than the latter. This means that aerodynamic heating, in the transition region of a reattaching supersonic boundary layer, can become more severe than expected, even with a fully turbulent flow. Author

N65-34650 Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
TRANSITION REVERSAL ON A FLAT PLATE AT HYPERSONIC SPEEDS
B. E. Richards and J. L. Stollery *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 477–501 refs (See N65-34635 22-12)

The variation of transition Reynolds number with wall temperature has been studied experimentally using a sharp-edged smooth flat plate. Early measurements were made at Mach numbers of 7.5 and 10 in a conical flow. More recently some experimental data at $M = 8.2$ have been obtained in a more uniform stream. These more recent data are reported in this note. The transition region was determined from focussed shadowgraph pictures and checked by taking heat transfer rate measurements along the plate and pitot pressure traverses through the boundary layer. Indications are that for a given unit Reynolds number, plate geometry and Mach number it is possible for the transition point to first move back, then advance and finally again recede as the wall temperature is reduced. This pattern of movement supports the theoretical prediction of Reshotko (1963). Author

N65-34653# Advisory Group for Aeronautical Research and Development, Paris (France).
RECENT DEVELOPMENTS IN BOUNDARY LAYER RESEARCH, PART II
May 1965 503 p refs Proc. of a Specialists' Meeting, AGARD Fluid Dyn. Panel, Naples, 10–14 May 1965
(AGARDograph-97, Pt. II)

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18. THE THREE-DIMENSIONAL SEPARATION OF A PLANE INCOMPRESSIBLE LAMINAR BOUNDARY LAYER PRODUCED BY A CIRCULAR CYLINDER MOUNTED NORMAL TO A FLAT PLATE D. J. Peake and R. D. Galway (Natl. Aeron. Estab.) p 1049–1080 refs (See N65-34671 22-12)

N65-34654 Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany). Institut für Aerodynamik

THREE-DIMENSIONAL BOUNDARY LAYERS ON ROTATING BODIES AND IN CORNERS

J. Steinheuer *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 567–611 refs (See N65-34653 22-12)

In the investigation of the boundary layer in corners three types of flow have been studied: flow along a rectangular corner consisting of two flat plates with the free stream direction parallel to the intersecting line; the same configuration as above but with a pressure gradient in the main-stream direction imposed on the flow; and the more general case of the flow in a corner formed between a profile and a flat plate. The first two cases deal with pure boundary layer interference while in the third case an additional complexity arises due to the pressure field induced on the flat plate. This case is characterized by separation of the boundary layer on the flat plate in front of the profile and the resulting formation of a vortex. In all three cases measurements of the velocity profiles have been carried out. With the aid of momentum theory and by the use of certain empirical expressions for the wall shear stress gained from the experiments, K. Gersten was able to describe theoretically the interference effects on the boundary layer development for cases (1) and (2). Author

N65-34655 California Univ., Los Angeles. Dept. of Engineering.

EXAMPLES OF BOUNDARY LAYERS IN ROTATING FLOWS

N. Rott and W. S. Lewellen (Aerospace Corp.) *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 613–635 refs (See N65-34653 22-12)

Approximate momentum-integral methods and exact similarity solutions for boundary layers in rotating fluids are discussed, with particular attention focused on the "terminal" similarity problem at the axis of rotation for a fluid rotating over a stationary wall. For the outer rotating flow, it is shown that in general viscous effects cannot be ignored even in the limit of very high Reynolds numbers since a strong interaction may exist between the end-wall boundary layers and the rotating core. Two examples are treated which illustrate these effects. In the first, a driven vortex is considered which is confined by a cylindrical chamber. The second example deals with the flow between a stationary and a rotating disk. Author

N65-34656 Illinois Univ., Urbana.

AUXILIARY FUNCTIONS OF THREE-DIMENSIONAL TURBULENT BOUNDARY LAYERS

S. L. Soo *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 637–665 refs (See N65-34653 22-12)

The general aspects of three-dimensional motion over a body of revolution were explored by extending the momentum integral method. Auxiliary function and separation of turbulent boundary layer in the three-dimensional motion were determined by introducing pertinent shape factors with extension of two-dimensional relations and by computing from recent experimental results. Designs based on imminent separation were illustrated. Author

N65-34657 Technische Hochschule Aachen (West Germany).

LAMINAR BOUNDARY LAYER FLOW AT SURFACES WITH LONGITUDINAL CURVATURE

F. Schultz-Grunow *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 667–673 refs (See N65-34653 22-12)

A boundary layer theory is presented which considers terms of the order of the inverse square root of the Reynolds number and exactly the Lamé coefficients. In order to provide analytic solutions conditions for similar profiles are derived including as limiting cases the flat plate, the wedge and the stagnation point flow. In this way a boundary layer equation is derived which includes these limiting cases. A special case is depicted with constant pressure along the edge of the boundary layer. Numerical results give a detailed insight on the influence of concave and convex curvature on the different boundary layer thicknesses, the wall friction, the shear stress and pressure distribution across the boundary layer the longitudinal and lateral velocity profiles. Finally the heat transfer is calculated. An appreciable influence exists in the heat transfer problem on the numerical factor and the exponent of Prandtl number. At the isolated concave wall the recovery temperature can exceed the stagnation point temperature. Author

N65-34658 Naples Univ. (Italy). Aerodynamics Institute.
ON SOME NEW CLASSES OF SIMILAR THREE-DIMENSIONAL INCOMPRESSIBLE BOUNDARY LAYERS
L. G. Napolitano and F. Manzo *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 675–714 refs (See N65-34653 22-12)

The present paper is concerned with two new classes of similar solutions for a three-dimensional incompressible laminar boundary layer over a non-developable surface in a flow without axial symmetry. By starting from the basic equation written in a system of geodesic coordinates and by applying them to the Mangler transformation with the hypothesis that flow symmetry is destroyed by kinematic, rather than geometrical, conditions a system of equations is obtained for which standard techniques provide the formal proof of the existence of classes of similar solutions for types of "outer" flows (suitably normalized). The pertinent systems of total differential equations thus derived are solved for a number of indicative values of three parameters by means of electronic computing machines. A detailed analysis of the results of these computations, in terms of velocity profiles and shear stresses at the wall, completes the paper. Author

N65-34660 Consiglio Nazionale delle Ricerche, Rome (Italy). Centro Ricerche Aerospaziali.
THREE-DIMENSIONAL EFFECTS IN THE HYPERSONIC LAMINAR BOUNDARY LAYER
M. Trella and F. Calabria *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 755–794 refs (See N65-34653 22-12)

The paper investigates three-dimensional effects in the laminar boundary layers in the relatively simple problem of flow in the neighborhood of a plane of symmetry; external hypersonic conditions and similar solutions are considered. This point of view is here resumed in order to provide additional information for cases with various wall temperatures, suction and injection, slip at the wall, inflow and outflow from the plane of symmetry, favourable and adverse pressure gradient in the longitudinal direction. Prandtl and Lewis Numbers are taken equal to one and a linear viscosity-temperature relation is assumed throughout the paper. Author

N65-34661 Poitiers Univ. (France). Faculté des Sciences.
THE THREE-DIMENSIONAL BOUNDARY LAYER IN THE TURBULENT FLOW OF A COMPRESSIBLE FLUID: THE CASE OF ATHERMANOUS WALLS [LA COUCHE LIMITE TRIDIMENSIONNELLE EN REGIME TURBULENT D'UN FLUIDE COMPRESSIBLE: CAS DE LA PAROI ATHERMANE]
Ernest A. Eichelbrenner *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 795–827 refs In FRENCH; ENGLISH summary (See N65-34653 22-12)

The characteristic values of compressible boundary layers in a turbulent flow, with athermanous walls, are calculated by an integral method, on three-dimensional obstacles. The usual simplification (prevalence principle: cross-flow not taken into account in the first approximation) is inapplicable; therefore, the crosswise velocity component is retained, and expressed by means of a generalization of Johnston's triangular pattern. As far as the simplification is concerned, a "preponderance" principle is accepted, which is based on the assumption, confirmed by tests, that the streamwise velocity component retains certain two-dimensional characteristics (shape of profile, temperature distribution, friction). The equations are then solved by an iterative method. A few partial results obtained so far are promising; a rather complex calculation (flattened ellipsoid with incidence) is in progress. Author

N65-34662 Royal Aircraft Establishment, Farnborough (England).
EXPERIMENTAL MEASUREMENTS IN A THREE-DIMENSIONAL TURBULENT BOUNDARY LAYER IN SUPERSONIC FLOW
M. G. Hall *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 829–853 refs (See N65-34653 22-12)

Measurements of mean values in time of pitot pressure and flow direction have been made in the boundary layer over the insulated sidewall of a specially-constructed supersonic nozzle. The external flow first accelerated and then decelerated, and the cross-wise pressure gradients were such that the boundary layer cross-flow was first in one direction and then in the opposite, as happens over wings with swept leading-edges. The external Mach number ranged between 1.6 and 2.0. Boundary layer traverses were made at intervals along external streamlines; from each traverse, profiles of Mach number and streamwise and cross-wise components of velocity were derived. The results were supplemented by measurements skin friction using surface-tubes. A preliminary analysis reveals serious limitations in the assumed forms for the cross-flow profiles, but there is evidence that the streamwise component behaves as it would in an equivalent two-dimensional boundary layer. Author

N65-34665 Royal Aircraft Establishment, Farnborough (England).
THE LAMINAR BOUNDARY LAYER ON AN INCLINED CONE
J. C. Cooke *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 909–931 refs (See N65-34653 22-12)

A solution to the problem of incompressible conical flow past a cone is presented, in which the boundary layer equations are solved by an implicit finite difference procedure. Comparisons are made with experiments by Rainbird, Crabbe and Jurewicz, and with calculations made by Crabbe who used an approximate method due to Cooke. As far as the present calculations go they agree reasonably well with experiment and show that the approximate method gives a fair overall picture. As yet it has not been possible to carry the procedure very far downstream but it is expected that the method can be modified to improve this. The equations for the extension to compressible flow are written down and they can in principle be solved by the same technique. Author

N65-34671 National Aeronautical Establishment, Ottawa (Ontario). High Speed Aerodynamics Section.
THE THREE-DIMENSIONAL SEPARATION OF A PLANE INCOMPRESSIBLE LAMINAR BOUNDARY LAYER PRODUCED BY A CIRCULAR CYLINDER MOUNTED NORMAL TO A FLAT PLATE
D. J. Peake and R. D. Galway *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 1049–1080 refs (See N65-34653 22-12)

The properties of a laminar, incompressible boundary layer in proximity to a circular cylinder protruding from a flat wall have been investigated by experiment and by calculation to yield the limiting streamlines and the three-dimensional primary separation line. Use was made of the N.A.E. water tunnel for the experiment. Fluorescent dye filaments emitted from wall orifices enabled the limiting streamlines and the primary separation line to be observed. The calculation method employs the small cross-flow, three-dimensional momentum integral equations in a form given by Cooke. The practical subcritical cylinder/wake flow was represented analytically by the potential system of a circular cylinder in a uniform mainstream, but modified by a line source flow in the vicinity of the cylinder rear stagnation point. When the surface shear stress vectors (relative to the external streamlines) were plotted, they coalesced into an "envelope" upstream of the cylinder to define the primary separation line. A comparison between the positions of the envelope and the experimental line indicate reasonable agreement. Author

N65-34712# Oklahoma State Univ., Stillwater. Graduate School.
TRANSIENT FLOW FIELD ANALYSIS OF A PLANE BLAST WAVE INTERCEPTING A STATIONARY CONE AT ZERO ANGLE OF ATTACK
William N. Jackomis (Ph.D. Thesis) May 1965 197 p refs (AD-618570)

A method for the transient analysis for the stationary cone was developed. Extensions of several methods were utilized and made compatible with flow conditions to provide a continuous flow solution. An approximate solution was used to obtain the shock diffraction pattern past the forebody. This solution was shown to be in close agreement with experimental shock tube tests. The shock wave configuration and flow field properties were adapted to provide initial conditions for the blast-base interaction. The numerical solutions show the feasibility of solving complicated axisymmetric flow fields to determine the effects of governing variables. The results of the blast-base interaction solution were used to mate the blast passage with the formation of the separated flow region behind the body. R.W.H.

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N65-33550# Michigan Univ., Ann Arbor. Infrared Physics Lab.
PROCEEDINGS OF THE THIRD SYMPOSIUM ON REMOTE SENSING OF ENVIRONMENT
Feb. 1965 795 p refs Symp. held at Ann Arbor, 14–16 Oct. 1964
(Contract Nonr-1224-(44))
(Rept.-4864-9-X; AD-614032)

Symposium papers in the field of remote sensing of environment, its potential in scientific research and engineering practices, and some of the factors that are important to growth of the field are presented. For individual titles see N65-33551–N65-33603.

N65-33566 National Bureau of Standards, Boulder, Colo.
A METHOD FOR THE DETERMINATION OF THE TROPOSPHERIC TEMPERATURE STRUCTURE FROM GROUND-BASED MEASUREMENT OF OXYGEN EMISSION
E. R. Westwater *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 245–256 refs Sponsored by Army Electron. Res. and Develop. Lab. (See N65-33550 22-13)

A method of determining temperature structure of the lower 5 km of the atmosphere using brightness temperature measurements from a vertically oriented antenna in the frequency region 50-55 Gc/s is described. The thermal emissions in this region are due principally to a series of oxygen absorption lines centered near 60 Gc/s. The temperature is represented by a polynomial expansion whose coefficients are initially determined with use of a standard absorption model. Subsequent iterations are made until a self-consistent set of absorption coefficients (as determined from the Van Vleck formula) and temperature expansion coefficients is obtained. Power series and Chebyshev polynomial temperature determinations are compared. The effect of experimental errors on the solutions is discussed. Author

N65-33569 Barringer Research, Ltd., Rexdale (Ontario).
DEVELOPMENTS TOWARDS THE REMOTE SENSING OF VAPOURS AS AN AIRBORNE AND SPACE EXPLORATION TOOL
A. R. Barringer *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 279–292 (See N65-33550 22-13)

The remote sensing of geochemical parameters is investigated. The techniques under study and development are concerned with sensing the dispersion of volatile components of orebodies or their oxidation products in the surface soils and in the air above. The elements and compounds of interest include mercury, iodine and sulphur dioxide in connection with metal bearing deposits, and hydrocarbon gases and iodine in association with oil fields. Author

N65-33570 Bear Creek Mining Co., Denver, Colo.
INFRARED GEOLOGY
D. W. Strangway and R. C. Holmer (Kennecot Copper Corp.) *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 293–320 refs (See N65-33550 22-13)

Airborne infrared work in an attempt to detect patterns related to geology or the presence of oxidizing sulphides is presented. The results encountered have shown that certain microclimatological effects are very important. Among these are the hill effect shown by small topographic features bathed in warm air under thermal inversion conditions. Major faults are evidently reflected in some cases as are areas of subterranean hot water. These observations have been confirmed by ground temperature measurements in holes 2-3 feet deep. The feasibility of using microwave systems has also been investigated. Some limited experiments on the absorption of microwave energy by sand and water mixtures indicate that such measurements would be useful. Author

N65-33580 Office of Naval Research, Washington, D. C.
GEOGRAPHIC RESEARCH POTENTIAL OF EARTH SATELLITES
Robert H. Alexander *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 453–468 ref (See N65-33550 22-13)

A study of the geographic potential of observations and experiments which might be carried out from the remote vantage of earth-orbiting spacecraft is presented. The investigation will involve both the value to the science of geography and the expected practical applications of an earth-viewing orbiting laboratory and other possible geographic satellite systems. Early emphasis will be on problems of systematizing and managing the flow of geographic information which would result from such a program. Author

N65-33582 Texas Instruments, Inc., Dallas.
SOME FUNDAMENTALS IN NON-CONTACT ELECTROMAGNETIC SENSING FOR GEOSCIENCE PURPOSES
Frank E. Kinsman *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 495–516 (See N65-33550 22-13)

This paper presents some conventional and non-conventional airborne sensing techniques used for geophysical data collection. State-of-the-art and developmental types of sensors which may become standard tools of the future are described. The value of data collected in various portions of the spectrum is demonstrated and some critical problems awaiting solution are identified. Pertinent geophysical data collected by some of the newer types of sensors are also presented. Author

N65-33595 Woods Hole Oceanographic Inst., Mass.
THE OUTLOOK FOR OCEANOGRAPHIC OBSERVATIONS FROM SATELLITES
Gifford C. Ewing *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 691–716 ref (See N65-33550 22-13)

Conclusions are discussed on the feasibility of making oceanographic observations from manned orbiting laboratories. Potentialities of the newer remote sensing techniques including visual, photographic, infrared, passive microwave, radar, and telemetering buoys are described. Recommendations are made as to areas in which the outlook for meaningful oceanography from space appears promising. Topics considered are sea surface temperature, ocean currents, sea level and tsunamis, marine meteorology, ocean waves, sea ice, oceanographic forecasting, marine biology, coastal geography and marine geology, and telemetering buoys. C.T.C.

N65-33596 California Univ., San Diego.
THE USE OF AN INFRARED MAPPER IN THE STUDY OF SMALL-SCALE OCEAN CIRCULATIONS
William Mc Leish *In* Mich. Univ. Proc. of the 3d Symp. of Remote Sensing of Environment Feb. 1965 p 717–735 refs (See N65-33550 22-13)

This paper presents a few of the results which have been obtained through the use of an infrared mapper in studying the small scale circulations of the near-surface layers of the ocean. Experiments are described in which this scanner was used as the sensor in tests of surface circulations, operated in conjunction with a ship. The role of this scanner in a study of the "windslick" problem of ocean circulations is described in detail. Author

N65-33597 Coast and Geodetic Survey, Washington, D. C.
FACTORS IN MEASUREMENT OF ABSOLUTE SEA SURFACE TEMPERATURE BY INFRARED RADIOMETRY
G. A. Berberian, A. H. Oshiver, J. R. Clark, and R. B. Stone (Fish and Wildlife Service, Highlands, N. J.) *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 737–762 Prepared jointly with Fish and Wildlife Service, Highlands, N. J. (See N65-33550 22-13)

Experiments were recently performed with aircraft and surface vessels to investigate techniques for radiometric measurement of absolute sea surface temperature in the 8 to 14 micron wavelength region. The objectives of the investigation were to evaluate existing instrumentation and techniques for accurate nearshore thermal mapping and to determine the effects of significant variables, primarily atmospheric water vapor. In addition, it was intended to explore the predictability of sub-surface water temperature from the radiometric temperature. The repeatability of a set of runs at 50 ft altitude compared to variations between runs at 500 ft altitude suggest the extent of influence of atmospheric moisture variations. Almost constant relationships under the existing conditions were found between shipboard radiometer and contact thermistor measured temperatures. Effects of several other experimental variables were evaluated. Author

N65-33598 Space-General Corp., El Monte, Calif.
APPLICATION OF MICROWAVE RADIOMETERS TO OCEANOGRAPHIC MEASUREMENTS
A. Mardon *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 763–779 ref (See N65-33550 22-13)

The following material is intended to discuss more specific application possibilities of radiometers to oceanographic measurements. Fortunately, the experimental and analytical work already cited can be directly related to such a possibility. Parameters of specific interest to oceanographers which we are confident will be ultimately measured with radiometers include: (1) Thermometric temperature of the sea (through fog), (2) distribution of water vapor above the sea, (3) determination of the sea state and sea swell vector, (4) distribution of ice (through fog), (5) thickness of level ice over water, (6) distribution of condensed water vapor over the sea, and (7) atmospheric temperature as a function of altitude. Author

N65-33599 HRB-Singer, Inc., State College, Pa.
INFRARED IMAGE APPLICATIONS IN STUDIES OF THE MARINE ENVIRONMENT
Gustavo A. Antonini *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 781–788 refs (See N65-33550 22-13)

Recent geomorphic studies utilizing an airborne infrared line-scanner indicates the applicability of this thermal sensor to near-instantaneous electronic mapping of hydro/thermo dynamic processes within oceanic and near-shore environments. Infrared imagery is presented and analyzed in terms of surface water manifestations of turbulent flow features, i.e., eddies and countercurrents. Author

N65-33600 Army Cold Regions Research and Engineering Lab., Hanover, N. H.
INFRARED SEA ICE RECONNAISSANCE
James H. Mc Lerran *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 789–799 refs (See N65-33550 22-13)

Infrared sensing of sea ice has been studied over a four year period and has shown great promise. Infrared sensing has shown some advantages over other imaging systems. It has nighttime capability and there is some relationship between thermal radiation and ice thickness. This paper presents a few illustrations of infrared imagery of sea ice with a discussion

of the interpretation of each illustration. Applications and limitations are discussed briefly. Author

N65-33602 Space-General Corp., El Monte, Calif.
MICROWAVE RADIOMETRIC MEASUREMENTS OF ICE AND WATER
H. G. Pascalar and R. T. Sakamoto *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 803–811 ref (See N65-33550 22-13)

This paper describes an experiment of ice measurements with a passive microwave radiometer. The discussion concerns itself with measurements of ice, the equipments used, and the data obtained. In addition, the theoretical basis for the observed phenomena including both multilayer and wave dependence is given. Consideration is given to attenuation, apparent temperature and interference effects, etc. The paper also indicates the possible utility of microwave radiometry in various ice applications. Author

N65-33705*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AURORA AND THE LOWER IONOSPHERE IN RELATION TO SATELLITE OBSERVATIONS OF PARTICLE PRECIPITATION
Bengt Hultqvist Apr. 1964 30 p refs
(NASA-TM-X-55018; X-611-64-107) CFSTI: HC $2.00/MF $0.50 CSCL 04A

The direct observations of electron precipitation by means of rockets and satellites is reviewed. Upon comparison of the observed energy fluxes with those expected on the basis of optical measurements of aurora, the agreement is found to be good. It is demonstrated that the satellite observations make understandable the observed variable degree of correlation between visual aurora and auroral absorption of radio waves. The precipitated electrons contribute significantly to the nighttime ionosphere not only in the auroral zone but also over the polar caps and in sub-auroral latitudes. It does not seem impossible that the observed precipitation of electrons is the main source of the nighttime ionization in the lower ionosphere. The airglow is briefly discussed in relation to observed particle precipitation. Finally, the recent demonstrations of the insufficiency of the Van Allen belt as a source for the precipitated electrons is briefly reviewed. Author

N65-33708*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
STRATOSPHERE AND MESOSPHERE DENSITY-HEIGHT PROFILES OBTAINED WITH THE X-15 AIRPLANE
Earl J. Montoya and Terry J. Larson [1963] 24 p refs Submitted for Publication
(NASA-TM-X-51734) CFSTI: HC $1.00/MF $0.50 CSCL 04A

Density-height profiles in the stratosphere and mesosphere were obtained from impact-pressure, velocity, and altitude measurements made on six X-15 research airplane flights. A form of the Rayleigh pitot formula was used for density computations. Because of pressure-instrumentation limitations and pressure lag, the maximum altitude for reasonably accurate density determination was considered to be about 65 km. Good agreement was obtained between temperatures calculated from faired density-height profiles of two X-15 flights and temperatures measured by rocketsondes launched near the times of flight from the Pacific Missile Range, Point Mugu, California. Author

N65-33728# White Sands Missile Range, N. Mex. Instrumentation Development Directorate.
RESEARCH ON TERRAIN EFFECTS ON OPTICAL TURBULENCE GENERATION Final Report
John A. Roth Jan. 1965 63 p refs
(STEWS-ID-65-3; AD-460727)

The turbulence-generating potential of various surfaces was investigated by measuring the temperature profile from 0.5 to 24 feet above each surface. Surfaces investigated include sparsely-vegetated desert, a shallow lake, white sand, and vegetation. An attempt was made to determine a quantitative relationship between optical resolution and lapse rate by simultaneously measuring the temperature profile and photographing a target pattern through a 120 cm lens at one of the sites. Results of the temperature-profile measurements indicate that higher lapse rates exist over the vegetation tested than over the desert. The lapse rates over white sand and over water are appreciably lower than that over the desert. The results demonstrate that the optical turbulence increases rapidly with increasing lapse rate. Resolution-loss rates as high as twenty lines per millimeter per degree Centigrade temperature-difference, measured between points six inches and eighteen feet above the surface, were recorded. The relationship between the optical resolution and the lapse rate, together with the difference in lapse rate occurring over areas with different surfaces, demonstrate that when selecting a location for optical instrumentation the lapse-rate characteristics of the surface layer should be taken into account. Author

N65-33757# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
MOVEMENT OF WATER IN A FILM BETWEEN GLASS AND ICE
Pieter Hoekstra and R. D. Miller (Cornell Univ., Ithaca, N. Y.) May 1965 13 p refs
(Contract DA-11-190-ENG-23)
(CRREL-RR-153; AD-616315)

The properties of the film between glass and ice were studied. The transport of material in the thin film between the glass and ice is common to both types of experiments. The particles used were all glass spheres and cylinders and the equations for transport in this film are, therefore, written in spherical and cylindrical coordinates. It is assumed that the driving force for the movement of water molecules is proportional to the free-energy gradient. The experimental arrangement and apparatus are described. The process by which glass particles are carried upward by an advancing ice front is shown to be controlled by the transport of water in the film between the glass and the ice. A relationship, derived on the assumption that the transport is by diffusion, predicts the influence of the rate of advance of the ice on the size of the largest particle carried by the ice. The movement rate of particles embedded in ice resulting from a temperature gradient is mainly determined by the thickness of the unfrozen film between the glass and the ice. The thickness of the film decreases rapidly with temperature. Author

N65-33823*# Consultants and Designers, Inc., Arlington, Va.
ROUGH SKETCH OF A NEW THEORY OF CONTINENTS' FORMATION [EBAUCHE D'UNE THEORIE DE LA FORMATION DES CONTINENTS]
Jean Lagrula 22 Sep. 1965 6 p refs Transl. into ENGLISH from Compt. Rend. Acad. Sci. Geodynamique (Paris), v. 260, 21 Apr. 1965 p 4365–4367
(Contract NAS5-3760)
(NASA-TT-F-9900; ST-ES-10388) CFSTI: HC $1.00/MF $0.50 CSCL 08F

The essential characteristic of the distribution between the oceanic and continental domains (terms of 1st order of development into Prey's spherical functions) is compatible with an external origin of the differentiation: it would concern a total (antecambrian) glaciation occurring under astronomical conditions favoring a notable climatic asymmetry. The scheme

envisaged is in agreement with my law of permanence of the eustatic level. Author

N65-33833*# National Aeronautics and Space Administration, Washington, D. C.
SPECTRAL, ELECTROPHOTOMETRICAL, AND RADAR RESEARCHES OF AURORAE AND AIRGLOW [SPEKTRAL'NYYE, ELEKTROFOTOMETRICHESKIYE I RADIOLOKATSIONNYYE ISSLEDOVANIYA POLYARNYKH SIYANIY I SVECHENIYA NOCHNOGO NEBA]
V. I. Krasovskiy, ed. Sep. 1965 59 p refs Transl. into ENGLISH from Collection of Articles, IGY Program, Sect. IV, no. 6, USSR Acad. of Sci. (Moscow), 1961
(NASA-TT-F-107) CFSTI: HC $3.00/MF $0.50 CSCL 04A

A number of articles concerned with spectral, electrophotometrical, and radar observations of airglow and auroral emissions are presented. Articles are included on backscattering of radio waves by aurorae, data processing results of electrophotometric observations of airglow, hydroxyl emission bands and rotational temperature, populations of hydroxyl molecule vibrational levels, absolute photometry of aurora and airglow spectra, comparison of diurnal variations of frequency of appearance of auroral hydrogen emissions and radio reflections on 72 mc, relation of integral brightness of aurorae to geomagnetic field variations and short period oscillations of earth currents, and a generation mechanism of magnetic disturbances. R.N.A.

N65-33939# Royal Greenwich Observatory, Herstmonceux (England).
ROYAL OBSERVATORY BULLETINS, NO. 96: TIME AND LATITUDE SERVICE, JULY-SEPTEMBER 1964
London, HMSO, 1965 18 p CFSTI: HC $1.00/MF $0.50

The results of the Greenwich Time and Latitude service are contained in this bulletin. The Herstmonceux time and latitude observation were made with the Photographic Zenith Tube(P.Z.T.), and the results of individual plates were tabulated. The Time System U. T. 2 was determined for the Herstmanceux P.Z.T. observations by smoothing values of U.T. 2 minus the atomic clock Cs(H12). Reception times of seconds pulses superposed on standard frequency emissions were corrected for receiver lag. Two Sulzer 2.5 Mc/s quartz crystal oscillators, H20 and H21, were installed and brought into operational use. R.W.H.

N65-34022# Joint Publications Research Service, Washington, D. C.
INVESTIGATION OF THE PHYSICAL PARAMETERS OF THE EARTH'S CRUST
S. I. Subbotin 16 Sep. 1965 184 p refs Transl. into ENGLISH of Issled. Fiz. Parametrov Veshchestva Zemnoy Kory, Akad. Nauk Ukr. SSR. (Kiev), no. 11, 1964 123 p
(JPRS-32047; TT-65-32541)

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11. DISTRIBUTION OF THE CLARK RATIOS OF URANIUM WITHIN THE LIMITS OF THE UKRAINIAN CRYSTALLINE SHIELD Yu. G. Gerasimov, A. B. Tuktarova, and V. D. Maydanyuk p 133–141 refs

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13. PHYSICAL PROPERTIES OF THE ROCKS AND ORES OF THE KRIVOY ROG BASIN AND THE BELOZERSKIY IRON-ORE REGION V. N. Kholin, N. A. Schitov, and I. A. Garkalenko p 148–157 refs

14. ESTIMATE OF THE DISTORTING EFFECT OF THE RELIEF ON GEOTHERMAL PARAMETERS R. I. Kutas p 158–166 refs

15. THE NATURE OF THE TEMPERATURE VARIATION AS A FUNCTION OF DEPTH IN THE UPPER LAYERS OF THE EARTH'S CRUST R. I. Kutas p 167–172 refs

16. INVESTIGATIONS OF THE PERMANENT MAGNETIC FIELD AND PALEOMAGNETISM IN THE USSR Z. A. Krutikhovskaya and N. P. Mikhaylova p 173–180

N65-34064# Naval Ordnance Lab., White Oak, Md.
MICROMETEOROLOGICAL PHENOMENA OF UNDERWATER NUCLEAR EXPLOSIONS
George A. Young 14 Jan. 1965 37 p Presented at the Natl. Conf. on Micrometeorol., Salt Lake City, Utah, 14 Oct. 1964
(NOLTR-64-187; AD-614814)

The above-surface phenomena of Test Baker in Operation Crossroads (1946) are described in detail with emphasis on the primary base surge. Some recent theoretical results concerning the surge structure and behavior are summarized. The base surge from the Teapot ESS Underground Test is briefly described and compared with the Baker surge. Author

N65-34067# Pennsylvania State Univ., University Park. Ionosphere Research Lab.
THE MEASUREMENT OF PHASE AND AMPLITUDE RADIO WAVE INTERACTION AT UNIVERSITY PARK, PENNSYLVANIA, JANUARY–MARCH, 1965
A. J. Ferraro and H. S. Less 30 May 1965 50 p refs *Its* Sci. Rept. No. 239
(Contract AF 19(628)-4014; Grant NSF GP-846)
(AFCRL-65-420; AD-618213)

This report presents the data obtained from the measurement of phase and amplitude radio wave interaction during the period of 1 January 1965 through 31 March 1965. The work was carried out at the Ionosphere Research Laboratory, The Pennsylvania State University (N. Lat. 40°-47', W. Long. 77°-57'), University Park, Pennsylvania, U.S.A. The present work is categorized as "Miscellaneous Measurements" in the discipline of "Ionosphere" in the IQSY program. Author

N65-34079 Library of Congress, Washington, D. C. Aerospace Technology Div.

NOCTILUCENT CLOUD RESEARCH

Daniel W. Michaels *In its* Foreign Sci. Bulk., v. 1, no. 9 Sep. 1965 p 51–55 refs (See N65-34075 22-34)

East-bloc noctilucent cloud research, centering on studies of the nature, distribution, mechanism of formation, and morphology of these clouds, is briefly summarized. Among the observations reported are: (1) Noctilucent clouds resemble the zonal belts of Jupiter, Saturn, and the outer clouds of Mars in their external characteristics. (2) Experiments support the theory that noctilucent clouds are made up of an assimilation of fine crystals of ice. (3) Noctilucent clouds cannot occur without the intervention of the sun. (4) Rocket investigations indicate that the temperature of the mesopause sinks to minimal values of 150° to 175° K during the summer in the 60° to 70° latitudinal belt of the Northern Hemisphere. M.G.J.

N65-34101# National Academy of Sciences—National Research Council, Washington, D. C. Comm. on Atmospheric Sciences.

THE ATMOSPHERIC SCIENCES, 1961–1971. VOLUME II: SUMMARIES OF PLANNING CONFERENCES

1962 128 p

(PUBL.-946)

Summaries are presented of the planning conferences on *Atmospheric Physics and Chemistry; Atmospheric Dynamics and Atmospheric Structures and Circulations; Biometeorology; Engineering Applications;* and *New Technologies*. Specific areas of aeronomy, planetary atmospheres, atmospheric composition, cloud physics, climates, water resources, agriculture meteorology, air pollution abatement, and data processing and computing are among the subjects discussed in detail. E.E.B.

N65-34147# Raven Industries, Inc., Sioux Falls, S. Dak. Meteorology Dept.

LIGHT WINDS IN THE STRATOSPHERE (15 TO 24 km), PART TWO

E. M. Frisby, L. W. Cooper, and R. K. Engel Sep. 1965 68 p refs

(Contract Nonr-4347(00))

(Rept.-0765; AD-619536)

There is a smooth climatological transition in the pattern of light wind spells in the stratosphere between 15 and 24 km from pole to tropics. At high latitudes, light wind spells are largely confined to summer months, are plentiful in number and about equally distributed between the four altitudes—15, 18, 21 and 24 km. At mid-latitudes light wind spells are present in appreciable numbers in spring, summer, and fall, but tend to occur at 21 and 24 km in spring and fall, at 15 and 18 km in summer. This regime persists with slowly decreasing numbers of spells until a point is reached between 10 S and 15 S where light winds occur sporadically and show little preference for altitude or season. TAB

N65-34154# Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.

THE CONSTANCY OF THE WINDS IN THE LOWER STRATOSPHERE AND CONSTANT-LEVEL BALLOON FLIGHT PLANNING

George F. Nolan Jun. 1965 31 p refs *Its* AF Surveys in Geophys., No. 166

(AFCRL-65-468; AD-619805)

Values of constancy of the wind at the 30-mb level over most of North America, derived from coefficients of variation of the wind, are analyzed for each month. High values of constancy exist during the summer months with low values appearing in apparently well-defined patterns during the other months. These patterns of low constancy values, called areas of maximum wind variability, are especially persistent over the western United States during late winter and early spring. The data and analyses presented can be of aid to meteorologists planning probable trajectories for long duration, constant-level balloon flights, and can also serve as a basis for the level of confidence the operational forecaster places on long-duration flight trajectory predictions. Author

N65-34183# Sheffield Univ. (England). Dept. of Applied Mathematics

POWER SERIES SOLUTION OF THE F2 LAYER DIFFUSION EQUATION Scientific Report No. 2

R. G. Baxter, P. C. Kendall, and D. W. Windle 1 Mar. 1965 25 p refs Submitted for Publication

(Grant AF-EOAR-64-74)

(AFCRL-65-563; AD-619821) CFSTI: HC $1.00/MF $0.50

If the equatorial electron density profile in the region is known, the equilibrium electron density everywhere else can in theory be computed. A method is given for carrying out this process for regions within 30° of latitude of the dip equator for an exponential atmosphere of constant scale height and for symmetry about the dip equator. This is achieved by simplifying the diffusion equation for an isothermal atmosphere, then expanding in a power series, convergent at great height and whose coefficients are functions of latitude. The method is applied to a study of the distributions of electron density expected from an equatorial profile with a single maximum, similar to a Chapman profile. Author

N65-34189# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

FIELD TESTING OF A FLUORESCIEN–ZINC SULFIDE DUAL ATMOSPHERIC TRACER TECHNIQUE

P. W. Nickola Aug. 1965 25 p refs

(Contract AT(45-1)-1830)

(BNWL-103) CFSTI: $2.00

Four field experiments were conducted in investigation of the compatibility of fluorescein and fluorescent zinc sulfide as dual atmospheric tracers. The two tracers were emitted simultaneously from a common source and collected on common filters. Qualitative and quantitative comparisons of the sampled tracer distributions are presented. The agreement is good. Author

N65-34200# Joint Publications Research Service, Washington, D. C.

OBSERVATIONS OF VERTICALLY MOVING TURBULENCES AT IRKUTSK

N. P. Popov and O. S. Ploshchenko 28 Sep. 1965 6 p refs Transl. into ENGLISH from Geomagnet. i Aeronomiya (Moscow), v. 5, no. 4, Jul.–Aug. 1965 p 770–771

(JPRS-32169; TT-65-32662) CFSTI: $1.00

The vertically moving U-shaped turbulences, which appear in the region of the critical frequencies of the F2 layer and then move in the wake of the F2 layer, were studied through evaluation of the Irkutsk observational material. Used were vertical sounding data of the ionosphere for 1961 to 1963 including January and February 1964, as well as time-lapse photographs of the origin and development of the VMT. The described disturbances occurred much less frequently in summer than in winter. The frequency of their appearance increased sharply in the autumn and attained a maximum in the winter months, only to decline again with the beginning of March. The dependency of the frequency of appearance on the solar activity was established by the observed daily increase in activity with sunrise and the sharp drop in activity after sunset. It was concluded that the vertically moving turbulence is one of the manifestations of the action of the sun on the atmosphere of the earth. G.G.

N65-34218*# Geophysics Corp. of America, Bedford, Mass. Technology Div.
MEASUREMENT OF UPPER ATMOSPHERIC IONIZATION AND WIND WITH A COMBINED PAYLOAD Second Quarterly Report, 1 Nov. 1964–31 Jan. 1965
[1965] 19 p ref
(Contract NASw-1083)
(NASA-CR-67035) CFSTI: HC $1.00/MF $0.50 CSCL 08A

One of four scheduled vehicles (Nike Apache) was successfully launched and data on wind and electron density obtained. Attempts to obtain a sequence of measurements during a single night were not successful because of unsatisfactory weather conditions. A technical report entitled "Canister for Producing TMA Trails in the Upper Atmosphere" was prepared and is undergoing publication. Analysis of data from the rocket flights of this project is continuing, and data are being supplemented by a reevaluation of data from five earlier pairs of flights. Although the time interval between the two flights of each pair in the 1962 series detracts from the value, evidence indicates that the wind structure does not change rapidly enough to invalidate the data. Included are data on the effect of releasing sodium vapor or TMA on the DC-probe and telemetry system. S.C.W.

N65-34220# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
METHOD OF DETERMINING α EQUALS $n(H^+)/ne$ AND THE ION TEMPERATURE FROM MEASUREMENT OF PROTON-WHISTLERS
Stanley D. Shawhan and Donald A. Gurnett Apr. 1965 29 p refs
(Contract Nonr-1509(06))
(Rept.-65-9; AD-614716)

Formulas used to determine the concentration of H^+ ion relative to the electron concentration and the ion temperature from proton-whistler measurements are explained. Possible results of measuring proton-whistlers from all of the Injun III vlf data based on a preliminary study of local summer day and winter night are discussed. Suggestions are made for other measurements that can be made on vlf data to obtain the concentrations of He^+ and O^+ relative to the electron density. J.M.D.

N65-34232*# Nuclide Corp., State College, Pa.
THE DISTINCTION OF ROCK TYPES ON THE BASIS OF THEIR MASS SPECTRA, WITH SPECIAL REFERENCE TO LUNAR-SURFACE APPLICATIONS
Werner G. Deuser Washington, NASA, Sep. 1965 18 p refs
(Contract NASw-1062)
(NASA-CR-310) CFSTI: HC $1.00/MF $0.50 CSCL 08G

It is shown that the rock types most commonly expected to be encountered on the lunar surface can for the most part be readily distinguished, chemically, by plotting their relative concentrations of Fe, Mg and Al on a ternary variation diagram. The necessary data for characterizing an unknown as to rock type can be quite easily extracted from complete or partial mass spectra such as may be obtained by means of a robot mass spectrometer on the lunar surface. For most compositions, determination of only two nuclide or element ratios will characterize the sample. For others, the determination of one additional ratio or comparison with a few standard spectra previously obtained in the laboratory may be necessary to classify the unknown in terms of the chemistry of terrestrial or meteoritic equivalents. No quantitative assay of element concentrations is necessary for such a first classification. Author

N65-34375*# National Aeronautics and Space Administration, Washington, D. C.
ATMOSPHERIC TURBULENCE [ATMOSFERNAYA TURBULENTNOST']
N. Z. Pincus, ed. Sep. 1965 133 p refs Transl. into ENGLISH from Tr. Tsentr. Aerolog. Observ. (Moscow), no. 54, 1954 p 1–129
(NASA-TT-F-246) CFSTI: HC $4.00/MF $1.00 CSCL 04A

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1. SOME RESULTS OF THE EXPERIMENTAL INVESTIGATIONS OF THE ATMOSPHERIC TURBULENCE USING RADIOSONDES V. P. Belyayev, T. G. Beltadze, V. P. Litovchenko, V. D. Litvinova, V. P. Lominadze et al p 1–65 refs (See N65-34376 22-13)
2. THE TURBULENCE IN JETSTREAMS IN THE CLEAR SKY A. A. Reshchikova p 66–84 refs (See N65-34377 22-13)
3. APPLICATION OF THE BOUNDARY LAYER METHOD TO THE DETERMINATION OF THE PARAMETERS OF TURBULENCE IN THE FREE ATMOSPHERE V. A. Shnaydman p 85–94 refs (See N65-34378 22-13)
4. TURBULENCE IN THE PROXIMITY OF JETSTREAMS T. P. Krupchatnikova p 95–102 refs (See N65-34379 22-13)
5. SOME RESULTS OF THE DETERMINATION OF TURBULENCE CHARACTERISTICS IN JETSTREAMS V. D. Litvinova p 103–108 refs (See N65-34380 22-13)
6. APPLICATION OF A THERMOANEMOMETER ON AN AIRCRAFT N. K. Vinnichenko p 109–129 refs (See N65-34381 22-13)

N65-34376* National Aeronautics and Space Administration, Washington, D. C.
SOME RESULTS OF THE EXPERIMENTAL INVESTIGATIONS OF THE ATMOSPHERIC TURBULENCE USING RADIOSONDES
V. P. Belyayev, T. G. Beltadze, V. P. Litovchenko, V. D. Litvinova, V. P. Lominadze et al *In its* Atmospheric Turbulence Sep. 1965 p 1–65 refs (See N65-34375 22-13) CFSTI: HC $4.00/MF $1.00

The method and the apparatus for measuring atmospheric turbulences using radiosondes are described. The results of the theoretical and of the experimental investigations of the method as well as the turbulence characteristics over Moscow, Sukhumi and Tashkent are given. From annual observations over the Moscow region, the distribution of turbulence along the altitude and its seasonal variations, the data on the thickness of the turbulent layers, and on the stability of the turbulent zone as a function of time are given. The relationship between turbulence, the vertical temperature gradients and wind velocity are considered. Author

N65-34377* National Aeronautics and Space Administration, Washington, D. C.
THE TURBULENCE IN JETSTREAMS IN THE CLEAR SKY
A. A. Reshchikova *In its* Atmospheric Turbulence Sep. 1965 p 66–84 refs (See N65-34375 22-13) CFSTI: HC $4.00/MF $1.00

From the measurements of tossing in jet streams made from the airborne laboratory on the TU-104 aircraft, data were obtained on the probability of occurrence of turbulence as a function of the type of high altitude pressure field, the curvature of isohypses, the horizontal temperature gradients, wind, etc. The article also considers the vertical distribution of turbulent zones with respect to the axis of the jetstream and tropopause. Author

N65-34378* National Aeronautics and Space Administration, Washington, D. C.
APPLICATION OF THE BOUNDARY LAYER METHOD TO THE DETERMINATION OF THE PARAMETERS OF TURBULENCE IN THE FREE ATMOSPHERE
V. A. Shnaydman *In its* Atmospheric Turbulence Sep. 1965 p 85–94 refs (See N65-34375 22-13) CFSTI: HC $4.00/MF $1.00

The solution of the problem for the maximum wind velocity in the case of asymmetrical wind velocity distribution along the altitude is presented. It is shown that diffusion of the energy of turbulence through the maximum velocity surface is small. It is also shown that separate solutions may be found for closed systems of equations of motion and of energy balance of the turbulence in the lower and upper parts of the turbulent layer (with respect to the maximum wind velocity). The author expresses some opinions regarding the possibility of evaluation of the diffusion of the energy of turbulence and the determination of turbulence characteristics in any layer of the free atmosphere. Author

N65-34379* National Aeronautics and Space Administration, Washington, D. C.
TURBULENCE IN THE PROXIMITY OF JETSTREAMS
T. P. Krupchatnikova *In its* Atmospheric Turbulence Sep. 1965 p 95–102 refs (See N65-34375 22-13) CFSTI: HC $4.00/MF $1.00

Results of theoretical investigations into the problem of the characteristics of turbulence in jet streams in the case of a variable coefficient of turbulent exchange in the vertical plane of the jetstream are presented. Solutions are given for equations of motion and energy balance of turbulence in a "narrow" jet. The formulas obtained make possible the construction of a vertical velocity profile of the wind in jet streams and to calculate the thickness of the turbulent layer relative to the stream axis. Author

N65-34380* National Aeronautics and Space Administration, Washington, D. C.
SOME RESULTS OF THE DETERMINATION OF TURBULENCE CHARACTERISTICS IN JETSTREAMS
V. D. Litvinova *In its* Atmospheric Turbulence Sep. 1965 p 103–108 refs (See N65-34375 22-13) CFSTI: HC $4.00/MF $1.00

A method for calculating turbulence characteristics in jetstreams from radiosonde data is presented. Data are given for the magnitude of vertical gusts and the turbulence coefficient in the turbulent zones of these streams. Author

N65-34381* National Aeronautics and Space Administration, Washington, D. C.
APPLICATION OF A THERMOANEMOMETER ON AN AIRCRAFT
N. K. Vinnichenko *In its* Atmospheric Turbulence Sep. 1965 p 109–129 refs (See N65-34375 22-13) CFSTI: HC $4.00/MF $1.00

Construction of an aircraft thermoanemometer, which was developed on the basis of a stationary thermoanemometer setup is described. Methods for introducing corrections, processing oscillograms and determining errors of the apparatus are considered. Some test results are also presented. Author

N65-34442# Coast and Geodetic Survey, Washington, D. C.
A STUDY OF SATELLITE REQUIREMENTS FOR THREE DIMENSIONAL GEODESY
George F. Wirth Oct. 1963 40 p refs

The objective of this study is to compare self-illuminated satellites (active) with sun-reflecting satellites (passive) to determine which is more feasible for use in an optical observing program of world-wide satellite triangulation. Factors affecting this program are geometrical configuration between the orbit of the satellite and the actual network of triangulation stations, darkness, weather, optical observability of the satellite, satellites available or proposed, progress of the project, logistics, and cost. The conclusions of this study revealed that while the active satellites (Starlight type) have somewhat more observational ability, the passive satellites (Echo type) are more feasible because of their lower cost. The recommendations of this study support the use of passive type satellites in a scheme of world-wide satellite triangulation. Author

N65-34474*# National Aeronautics and Space Administration, Washington, D. C.
SHORT-PERIOD PULSATIONS OF THE EARTH'S ELECTROMAGNETIC FIELD Collection of Articles
A. G. Kalahnikov and V. A. Troitskaya, ed. Sep. 1965 144 p refs Transl. into ENGLISH of "Korotkoperiodicheskiye Kolebaniya Electromagnitnogo Polya Zemli, Sbornik Statey", IGY Program, Sect. III, no. 3, USSR Acad. Sci. (Moscow), 1961
(NASA-TT-F-104) CFSTI: HC $4.00/MF $1.00 CSCL 08N

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3. REGULARITIES IN THE EXCITATION OF SHORT-PERIOD PULSATIONS IN THE MIDDLE LATITUDES M. V. Okhatsimskaya, Yu. B. Rastrusin, I. I. Rokityanskiy, and R. B. Shchepetnov p 17–25 refs (See N65-34477 22-13)

4. SHORT-PERIOD PULSATIONS OF THE ELECTROTELLURIC FIELD P. A. Vinogradov p 26–42 refs (See N65-34478 22-13)

5. RAPID GEOELECTRICAL AND GEOMAGNETIC VARIATIONS AND THEIR REGULARITIES (ACCORDING TO OBSERVATIONS IN ASHKABAD) V. G. Dubrovskiy p 43–50 ref (See N65-34479 22-13)

6. CONTINUOUS PULSATIONS AND TRAIN-TYPE PULSATIONS IN THE ARCTIC AND THE ANTARCTIC V. A. Troitskaya p 51–76 refs (See N65-34480 22-13)

7. PRELIMINARY RESULTS OF THE EARTH CURRENT OBSERVATIONS AT TIKSI BAY E. P. Zubareva p 77–85 refs (See N65-34481 22-13)

8. PRELIMINARY RESULTS OF THE EARTH CURRENT OBSERVATION AT THE BARENTBURG STATION (SPITZBERGEN) N. M. Nikitina p 86–93 (See N65-34482 22-13)

9. GIGANTIC PULSATIONS IN THE SOVIET ARCTIC DURING THE 1935–1956 PERIOD E. P. Zubareva, G. I. Korobkova, N. M. Nikitina, and V. A. Troitskaya p 94–102 refs (See N65-34483 22-13)

10. ON THE NONPERPENDICULARITY OF THE E AND H VARIATION VECTORS OF THE ELECTROMAGNETIC FIELD OF THE EARTH O. M. Barsukov and K. Yu Zybin p 103–111 refs (See N65-34484 22-13)

11. BEAT-TYPE PULSATIONS (PEARLS) IN THE EARTH'S ELECTROMAGNETIC FIELD (T ~ 1–4 sec) V. A. Troitskaya p 112–124 refs (See N65-34485 22-13)

12. ON THE CHARACTERISTIC INTERVALS OF THE PULSATIONS DIMINISHING BY PERIODS (10–1 sec) IN THE EARTH'S ELECTROMAGNETIC FIELD AND THEIR CONNECTION WITH PHENOMENA IN THE UPPER ATMOSPHERE V. A. Troitskaya and M. V. Mel'nikova p 125–136 refs (See N65-34486 22-13)

13. SOME REGULARITIES IN THE BEHAVIOR OF THE VERTICAL COMPONENT OF A STABLE (pc) REGIME OF SHORT-PERIOD PULSATIONS OF THE GEOMAGNETIC FIELD O. V. Bol'shakova, K. Yu. Zybin, and N. F. Mal'tseva p 137–138 (See N65-34487 22-13)

14. SOME RESULTS OF OBSERVATIONS OF THE VARIATION VECTORS IN THE HORIZONTAL COMPONENT OF THE GEOMAGNETIC FIELD OF THE EARTH A. G. Kalashnikov and K. Yu Zybin p 139 (See N65-34488 22-13)

15. ON THE SHORT-PERIOD VARIATIONS OF THE ELECTROMAGNETIC FIELD OCCURRING SIMULTANEOUSLY OVER LARGE TERRITORIES A. G. Kalashnikov and Yé. N. Mokhova p 140 (See N65-34489 22-13)

N65-34475* National Aeronautics and Space Administration, Washington, D. C.

SHORT-PERIOD PULSATIONS OF THE EARTH'S MAGNETIC FIELD

V. I. Afanas'yeva *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 1–8 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

The main conclusions of the Soviet paper on the earth's magnetic field are based on study of conventional magnetograms from four observatories. Short period pulsations are a manifestation of the electromagnetic pulsations of the external atmosphere of the earth, however, the disclosed SPP regularities indicate that not all of the outer atmosphere, concentric about the earth, acts in the same way to promote the appearance of SPP. There are apparently certain regions in the outer atmosphere with ionization sufficiently high so that pulsations in these regions create SPP on the earth. There are three such regions; one at daytime, middle and low latitude, the second is over the morning, high latitude area, and the third region is over the night side of the earth at the middle, subarctic latitudes. Ionization in the first region is due to wave radiation of the sun and ionization in the second and third regions is due to the sun's corpuscular radiation. M.W.R.

N65-34476# National Aeronautics and Space Administration, Washington, D. C.

ON CERTAIN REGULARITIES OF THE DISTURBED FIELD OF EARTH CURRENTS

V. V. Kebuladze *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 9–16 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

A study of the structure and changes of the electrical field of earth currents was based on storms and disturbances of long duration, and short period disturbances of stable conditions and pulsation trains. Seven hundred and eight storms and disturbances were included and tabulated together with the observation, isolation, and accurate classification of the individual types of short period disturbances constitute a more complex task than the study of long-running electrotelluric storms and disturbances. A definite regularity in the distribution of beginnings, endings, and active periods of electrotelluric disturbances was noted. The largest number of disturbances begins during the period from 0400 to 1800 hours with a maximum between 1300 and 1400 hours, according to universal time. The largest number of pulsation trains, as a rule, is coordinated with the maximum development of activity in electrotelluric disturbances. W.M.R.

N65-34477* National Aeronautics and Space Administration, Washington, D. C.

REGULARITIES IN THE EXCITATION OF SHORT-PERIOD PULSATIONS IN THE MIDDLE LATITUDES

M. V. Okhatsimskaya, Yu. B. Rastrusin, I. I. Rokityanskiy, and R. B. Shchepetnov *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 17–25 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Investigations, encompassing more than 1/3 of the earth indicate a general regularity in the excitation of short period pulsations for the middle latitudes. The pulsations appear in two regimes; continuous (with periods of 15 to 40 sec for hours) and train-type (during night hours in groups with periods of 50–90 sec for minutes or hours). The onset of the maximum or minimum of a regime of SPP in terms of universal time depends upon the longitude of the observation point and the diurnal variation of continuous and train type pulsations is controlled by local time. In addition to a frequency-amplitude analysis, the study of the predominant direction of the flux of the earth's currents was made at the middle latitude stations. Taking into account a direct connection between the excitation of SPP and solar illumination, the seasonal changes in the SPP occur less and less from the poles toward the equator. W.M.R.

N65-34478* National Aeronautics and Space Administration, Washington, D. C.

SHORT-PERIOD PULSATIONS OF THE ELECTROTELLURIC FIELD

D. A. Vinogradov *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 26–42 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Examining the distribution of continuous pulsations according to hours of the universal time, the moments of the minimum of pulsation differ little from the moments of the maximum going from east to west. Therefore the continuous pulsations of two stations differing by 180° in longitude must occur on counterphase. It is possible to say (considering the above-mentioned parallelism between continuous pulsation and the diurnal changes of the intensity thereof) that at any given moment the most intensive continuous pulsations are observable on the day side while the weakest continuous pulsations are observable on the night side. Local time measures development of short-period pulsations, occurring mostly during day. For pulsations of the train type, conversely, maximum development and greatest frequency of appearance on the night side of the earth are characteristic. W.M.R.

N65-34479* National Aeronautics and Space Administration, Washington, D. C.

RAPID GEOELECTRICAL AND GEOMAGNETIC VARIATIONS AND THEIR REGULARITIES (ACCORDING TO OBSERVATIONS IN ASHKHABAD

V. G. Dubrovskiy *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 43–50 ref (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Geomagnetic and geoelectrical variations were investigated together with the diurnal and seasonal regularities, the distribution according to periods, the geophysical phenomena, particularly with the level of geomagnetic activity and polar aurorae. Geomagnetic activity does not alter the probability of pulsation excitation, which is seasonal (excitation is highest in summer and lowest in winter). Gigantic pulses of geomagnetic and geoelectrical disturbances coincided in time with instrumentally recorded polar aurorae. The disturbances show a variation in the magnetograms with the earth-current vector strictly polarized in a NS direction, at an angle of 12.5 to the EW. W.M.R.

N65-34480* National Aeronautics and Space Administration, Washington, D. C.

CONTINUOUS PULSATIONS AND TRAIN-TYPE PULSATIONS IN THE ARCTIC AND THE ANTARCTIC

V. A. Troitskaya *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 51–76 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Further observations of short period pulsations during the International Geophysical Year were carried out at middle and low latitudes; these were classified again into continuous pulsations and train type pulsations. Continuous regular pulsations with periods of 15–40 sec are characteristic for the polar as well as for the middle latitudes. Pulsation trains which have a characteristic form in the middle latitudes, in the polar regions during the years of maximum solar activity either constitute one of the elements of the polar disturbance or are manifested as a feeble individual disturbance. In both cases they are devoid of the shape of the middle-latitude trains. The polar-night effect for regular continuous pulsations in the Arctic and Antarctic were observed and in the middle of the polar winter the number of hours with regular pulsation activity falls abruptly. In the Arctic there is the diurnal variation of continuous pulsations and excitation occurs principally in the interval of 0600–1700 hours local time with the maximum around local midday. W.M.R.

N65-34481* National Aeronautics and Space Administration, Washington, D. C.

PRELIMINARY RESULTS OF THE EARTH CURRENT OBSERVATIONS AT TIKSI BAY

E. P. Zubareva *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 77–85 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

During severe magnetic storms, the greatest coincidence is observable in the recordings (tellurograms) of elements of the magnetic field and of earth current components, disturbances of the latter being more clearly expressed. In leaving the shore of an Arctic bay, the intensity of the earth currents decreases, i.e., the so-called coastal effect in earth currents takes place. The meridional component is more intensive than the latitudinal component and is displaced in phase relative to the latter. The variable telluric field in the Arctic has elliptical polarization, the large axis of which is situated in a meridional direction. A very good positive correlation exists between the earth current disturbances and the magnetic field. The seasonal variation of the disturbance maximum in the earth currents and that of polar aurorae are in good agreement according to photographic and radio-location observations.

W.M.R.

N65-34482* National Aeronautics and Space Administration, Washington, D. C.

PRELIMINARY RESULTS OF THE EARTH CURRENT OBSERVATION AT THE BARENTBURG STATION (SPITZBERGEN)

N. M. Nikitina *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 86–93 (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Observations of the earth's electrical field at the Barentsburg Geophysical Station in the arctic are presented and discussed. Both slow and rapid registration techniques were used in obtaining measurements during the period October 1957 to June 1959. Data are presented on changes in resistance of the ground connections, seasonal variation of the average monthly maximum amplitudes of the earth's current field, seasonal variation of continuous pulsations, diurnal variations, and diurnal variation of beat-type pulsations. The most typical manifestations on earth current recordings at Barentsburg are long period pulsations of irregular shape with periods of 3 to 5 minutes; frequently pulsations with a lesser period are superimposed on them. Continuous pulsations, beat-type pulsations, and bay-type disturbances are reliably separable in registrations at this location. J.M.D.

N65-34483* National Aeronautics and Space Administration, Washington, D. C.

GIGANTIC PULSATIONS IN THE SOVIET ARCTIC DURING THE 1935–1956 PERIOD

E. P. Zubareva, G. I. Korobkova, N. M. Nikitina, and V. A. Troitskaya *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 94–102 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Gigantic pulsations in standard recordings of the magnetic field at Soviet arctic and antarctic observatories are discussed. The data presented in this report consist of the presence or absence of the pulsations by individual years between 1933 and 1957; duration, diurnal and seasonal variation, and geographic distribution of gigantic pulsations; and cases of simultaneous pulsation measurements at separate stations at polar and middle-latitude locations. The data indicate that gigantic pulsations have one or two fundamental periods, various harmonics of which are observable at specific stations depending on local conditions. All of the examined cases confirm the conclusion that gigantic pulsations are a disturbance of the earth's electromagnetic field, typical for the polar auroral zone and rapidly alternating to the south and north of it. J.M.D.

N65-34484* National Aeronautics and Space Administration, Washington, D. C.

ON THE NONPERPENDICULARITY OF THE E AND H VARIATION VECTORS OF THE ELECTROMAGNETIC FIELD OF THE EARTH

O. M. Barsukov and K. Yd. Zybin *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 103–111 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Investigations at the Lovozero and Borok stations indicate that the nonperpendicularity of the variation vectors of electrical intensity and horizontal magnetic force vectors can be explained by electrical heterogeneity (anisotropy) of the rocks at some depth under the surface at the observation points. The ellipse of anisotropy and the predominant directions of the electrical intensity and magnetic force vectors are given for the Lovozero station and the Borok station. Also, the diurnal course of azimuths at the Borok station is given. E.E.B.

N65-34485* National Aeronautics and Space Administration, Washington, D. C.

BEAT-TYPE PULSATIONS (PEARLS) IN THE EARTH'S ELECTROMAGNETIC FIELD (T 1-4 sec)

V. A. Troitskaya *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 112–124 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Study of the beat-type pulsations during the IGY was carried out on the basis of ultrahigh-speed continuous recordings of earth currents at a rate of 30 mm/min. The character of the excitation of these pulsations, their duration, and their distribution according to the hours of the day and by months are illustrated. The graphs indicate a predominance of short bursts of pulsations in the Arctic region, a large number of pulsation series in the middle latitudes, and a mixed pattern in Antarctica. This new characteristic class of short-period pulsations of the earth's magnetic field, pulsations of the beat-type, known as pearls, were detected at an extensive network of stations. The pulsations have a sharply limited spectral distribution of fractions of a second to 4 to 5 seconds. Pearls are a characteristic element of the macrostructure of magnetic storms, in particular of pulsation intervals diminishing by period that are observed for the largest of magnetic storms. The excitation of pearls is controlled both by local and universal time. E.E.B.

N65-34486* National Aeronautics and Space Administration, Washington, D. C.

ON THE CHARACTERISTIC INTERVALS OF THE PULSATIONS DIMINISHING BY PERIODS (10-1 Sec) IN THE EARTH'S ELECTROMAGNETIC FIELD AND THEIR CONNECTION WITH PHENOMENA IN THE UPPER ATMOSPHERE

V. A. Troitskaya and M. V. Mel'nikova *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 125–136 refs (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

The characteristic intervals of pulsations diminishing by periods (PDP) were observed in high-speed recordings of earth currents in the course of analyzing the microstructure of magnetic storms on the basis of continuous recordings. A diagram of the development of the PDP interval in its optimum expression is presented. Also, photographic representation of the recordings of a characteristic pulsation series is shown. Pulsations with periods of 1 to 4 sec are the most characteristic PDP element, since the pulsations can continue without damping for tens of minutes. According to the data one to four PDP intervals may be observed in the course of a magnetic storm. All of the large storms occurring during the IGY contained PDP intervals. The analysis presented indicates that the PDP intervals are characteristic morphological elements of disturbances of the earth's electromagnetic field in the course of a magnetic storm which is directly correlated with the infractions in the ionosphere and with the development of polar aurorae in the low latitudes. E.E.B.

N65-34487* National Aeronautics and Space Administration, Washington, D. C.

SOME REGULARITIES IN THE BEHAVIOR OF THE VERTICAL COMPONENT OF A STABLE (pc) REGIME OF SHORT-PERIOD PULSATIONS OF THE GEOMAGNETIC FIELD

O. V. Bol'shakova, K. Yu. Zybin, and N. F. Mal'tseva *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 137–138 (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

Some regularities in the behavior of the vertical component of short-period pulsations of the geomagnetic field observed with fluxmetric induction installations during the first six months of the IGY are discussed. It was established that the probability of the occurrence of pulsations with differing periods is unequal. The pulsations with periods of 20, 30, and 60 sec predominate. Pulsations with a 50-sec period are at least typical for all stations. It was also established that diurnal variations of the occurrence of pulsations with various periods differ. The time of onset of the extrema is shifted and the amplitude of the diurnal variations changes. Further, it was noted that for each station the time of onset of the extrema occurs at the same hours, regardless of the period. It is assumed that the diurnal variation of amplitude values is controlled by local time and that the frequency of occurrence of the pulsations is controlled by a more complex parameter than is the amplitude. E.E.B.

N65-34488* National Aeronautics and Space Administration, Washington, D. C.

SOME RESULTS OF OBSERVATIONS OF THE VARIATION VECTORS IN THE HORIZONTAL COMPONENT OF THE GEOMAGNETIC FIELD OF THE EARTH

A. G. Kalashnikov and K. Yu. Zybin *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 139 (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

The variation vector of the horizontal component of the geomagnetic field $\vec{H}$ is discussed. An azimuth was determined which keeps strictly to the predominant direction of the fluctuations of vector $\vec{H}$. Also, a distinct diurnal variation of vector $\vec{H}$ was determined, the maximum value of whose deviation from a northern direction is attained at 0400 to 0500 hours universal time. It was established that the $\vec{H}$ vector rotates and the directions of the rotation possess a clearly expressed diurnal variation. The rotation of the H vector counterclockwise was observed at night and morning hours and the rotation of the vector clockwise was observed at day and evening hours. It was further established that the directions of the changes of the $\vec{H}$ vector for the given period of time are perpendicular to the directions of the changes of the electrical vector $\vec{E}$ while the directions of the terminal points of vectors $\vec{E}$ and $\vec{H}$ coincide. E.E.B.

N65-34489* National Aeronautics and Space Administration, Washington, D. C.

ON THE SHORT-PERIOD VARIATIONS OF THE ELECTROMAGNETIC FIELD OCCURRING SIMULTANEOUSLY OVER LARGE TERRITORIES

A. G. Kalashnikov and Ye. N. Mokhova *In its* Short-Period Pulsations of the Earth's Electromagnetic Field Sep. 1965 p 140 (See N65-34474 22-13) CFSTI: HC $4.00/MF $1.00

The study of disturbances simultaneously occurring over large territories was undertaken by using the results of the complex registration of the vertical component of the magnetic field with the fluxmetric installations and of the horizontal component of the earth currents. Pulsations of the impulse, train, and microbay types were clearly distinguishable on the magnetograms and tellurograms due to similarity of shape and simultaneity of occurrence. The period, amplitude, time of occurrence, and amplitude ratio were determined. Obtained amplitude distribution cannot be explained by the latitudinal factor. It probably depends on differing geological structures of the regions where the stations are located, on continuous inhomogeneities in the ionosphere and in the upper atmosphere, and on coastal marine electric currents. E.E.B.

N65-34509*# National Aeronautics and Space Administration, Washington, D. C.

THEORY OF SHORT WAVE RADIATION FLUXES IN THE REAL ATMOSPHERE [TEORIYA SPEKTRAL'NYKH POTOKOV KOROTKOVOLNOVOY RADIATSII V REAL'NOY ATMOSFERE]

K. S. Shifrin, I. N. Minin, O. A. Avaste, and N. P. Pyatovskaya Oct. 1965 24 p refs Transl. into ENGLISH from Meteorol. Soveshch. (USSR), v. 6, 1963 p 30–44
(NASA-TT-F-272) CFSTI: HC $1.00/MF $0.50 CSCL 04A

Earlier work is summarized, and a simple theoretical model is developed to account for the behavior of the radiation fluxes in the short wave portions of the spectrum (infrared and visible) from the viewpoint of optical measurements in the clear real atmosphere. The model is devised so as to utilize most effectively those optical and atmospheric state variables which are easily measured (optical thickness, visible range, water content), providing initial parameters to complete the total conception, from which the remaining parameters can be calculated. The model can be used to calculate the intensities and fluxes with an error satisfactory for many practical applications. In formulating the model, the difficulties inherent in attempts to account simultaneously for scattering and absorption are circumvented by treating the visible and infrared parts of the spectrum separately, assuming a predominant scattering mechanism in the former, an absorption mechanism in the latter. Author

N65-34539# Denver Univ., Colo. Dept. of Physics.
ABSORPTION OF SOLAR RADIATION BY ATMOSPHERIC CO_2 Scientific Report No. 5
Thomas G. Kyle, David G. Murcray, Frank H. Murcray, and W. J. Williams Apr. 1965 53 p refs
(Contract AF 19(604)-7429; ARPA Order 363-62)
(AFCRL-65-290; AD-620034)

The absorption spectra of the 4.3 micron band was measured at altitudes from ten to thirty kilometers along slant paths in the atmosphere using the sun as a radiation source. These spectra were obtained by the use of a balloon-borne grating spectrometer having a resolution of 0.5 cm^{-1}. By making two assumptions it has been possible to calculate spectra using a small computer that agree quite well with the observed spectra. The primary approximations used were the assumption of like rotational structure for all isotopes and excited states, and the assumption of constant displacement between the various states of C^{12} and C^{13} At the higher altitudes the Lorentz broadening theory resulted in a satisfactory agreement between the calculations and the experimental results, but at the lower altitudes use of the empirical modification proposed by Benedict was necessary to obtain agreement in the region of the high frequency end of the band. The calculations cover the frequencies from 2235 cm^{-1} to 2415 cm^{-1} Author

N65-34547# Ohio State Univ. Research Foundation, Columbus. Inst. of Geodesy, Photogrammetry and Cartography.
ACCURACY OF GRAVITY GRADIENTS AT ELEVATIONS Scientific Report No. 16
Erwin Groten Jun. 1965 16 p refs *Its* Rept.-50
(Contract AF 19(628)-2771)
(AFCRL-65-523; AD-620040)

Formulas are derived for the computation of accuracy of the three components of gravity disturbance gradient at elevations as determined from surface anomalies. The earth is replaced by its tangent plane. Author

N65-34673# National Bureau of Standards, Boulder, Colo. Central Radio Propagation Lab.
IONOSPHERIC DATA, PART A
29 Jan. 1965 55 p
(CRPL-F-245, Pt. A)

N65-34677# Joint Publications Research Service, Washington, D. C.
SPECIFIC FEATURES OF PROPAGATION OF GROUND WAVES IN THE PERMAFROST ZONE
V. Ye. Kashprovskiy 28 Sep. 1965 6 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 5, no. 4, Jul.–Aug. 1965 p 768–770
(JPRS-32168; TT-65-32661) CFSTI: $1.00

The dependence of ground radio wave propagation in the permafrost zone on the local conductance on route, on the conductance of the terrain topography, and on the apparent conductance of the soil, was investigated. Ground penetration measurements and theoretical evaluations showed that the local soil conductance was determined by the presence of permafrost layers; the lower conductivity of frozen soils resulted in a lower dispersion effect. G.G.

N65-34682# Stanford Research Inst., Menlo Park, Calif.
FALLOUT MODELS AND RADIOLOGICAL COUNTERMEASURE EVALUATIONS
Carl F. Miller May 1965 20 p refs
(Contract N228-(62479)65702)
(AD-619902)

This report is a brief description of a fallout model and other submodels that have been formulated to assist in the assessment of radiological defense problems and in the evaluation of radiological countermeasures. The design of the model system emphasizes application to both short-term and long-term radiological problems of interest to civil defense. The types of input data that are utilized, the various important independent parameters that are considered in the models and submodels, and the types of output information are listed. Also, the major assumptions, constraints, and concepts involved in the mathematical construction of each model are summarized. The purpose of the report is to provide researchers on other civil defense investigations general background information on the composition and outputs of these models. The report does not include any of the mathematical formulations of the models. Author

N65-34692# Travelers Research Center, Inc., Hartford, Conn.
PREDICTION IN THE STRATOSPHERE
Frederick P. Ostby, Jr., Keith W. Veigas, and Bernard J. Erickson Bedford, Mass., AFSC, Electron. Systems Div., Jun. 1965 48 p refs Prepared for United Aircraft Corp. *Its* Rept.-7463-170
(Contract AF 19(628)-3437)
(ESD-TR-65-10; AD-618492)

This report describes a base technique for the 24- and 48-hr prediction of stratospheric contour height changes in winter at 100, 50, and 30 mb. On independent data, this technique yields superior results to persistence at all three levels and for both forecast intervals. Prediction equations are derived by applying the screening regression technique to atmospheric variables at a network of grid points surrounding a predicand point. Incorporation of predictors, based on perfect prognoses at lower levels, brings about a significant improvement in the results. Some improvement is also noted when a geographical stratification is employed. However, orientation of the grid network with the flow pattern did not result in any substantial improvement. Author

N65-34695# General Dynamics/Fort Worth, Tex.
ATMOSPHERIC DIFFUSION STUDIES AT THE NARF SITE Technical Report, 1 Oct. 1963–30 Sep. 1964

H. G. Bradbury Kirtland AFB, N. Mex., AF Weapons Lab., Jun. 1965 114 p refs
(Contract AF 29(601)-6213)
(FZK-206; WL-TR-64-156; AD-618101)

Four atmospheric diffusion experiments were conducted in the nuclear aerospace research facility area in order to study the dispersal and dilution factors of the atmosphere as they pertain to the release of airborne radioactivity in the area. Fluorescent dye was released to the atmosphere from a point near the reactor operations building and sampled downwind to measure depletion factors under varying meteorological conditions. The tests were performed with air temperature gradients ranging from slightly unstable to mildly stable (inversion) situations. The sampling data obtained were applied in the evaluation of the parameters associated with the statistical diffusion equation. Although the four tests were too few in number to provide substantial statistical data, the results show that under the poorest diffusion conditions experienced, the effluent depletion factors ranged from approximately 10^{-4} to 10^{-6} between 88 and 704 m from the release point. These factors are considerably less than those actually being applied under nuclear safety considerations within the reactor operations area. Author

N65-34722# Lincoln Lab., Mass. Inst. of Tech., Lexington.
AN APPROACH TO ESTIMATION IN SEISMIC EQUALIZATION Technical Note No. 1965-24
Robert Price 28 Jun. 1965 30 p refs
(Contract AF 19(628)-500; ARPA Order 512; Proj. Vela Uniform)
(ESD-TDR-65-272; AD-619020)

The "seismic equalization" problem is that of correcting the response at one station to match that at another station which may have different instrument characteristics and different (and unknown) local reverberation characteristics. In this note, the problem of seismic equalization is formulated mathematically, and that portion involving measurement or estimation of a transfer-function ratio is modeled and attacked on statistical terms first by an *ad hoc* procedure and then by the method of maximum likelihood. Author

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N65-33555 Michigan Univ., Ann Arbor. Inst. of Science and Technology.
THE MOTIVATION FOR MULTISPECTRAL SENSING
M. R. Holter and R. R. Legault *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 71–77 Sponsored in part by Army, AF, and NASA (See N65-33550 22-13)

The motivation for programs in simultaneous multispectral reconnaissance is described. It is shown that present methods of presenting imagery are deficient in that they cannot display in a useful form all the information that is obtainable. This is particularly true of the common attempts to use a "best" film-filter combination to obtain and present imagery. A practical method of presenting the results of multispectral sensing is described. Related succeeding papers are introduced. Author

N65-33559 Barnes Engineering Co., Stamford, Conn.
AN INFRARED TECHNIQUE FOR THE REMOTE DETECTION OF CLEAR AIR TURBULENCE
R. W. Astheimer *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 105–123 refs (See N65-33550 22-13)

A means for determining the vertical temperature profile of the atmosphere from a satellite, by sensing the radiation emitted at several wavelengths within an atmospheric absorption band has been suggested. The application of this technique to the determination of horizontal temperature distributions within the atmosphere and the detection of clear air turbulence is discussed. It is shown that by spectrally scanning the wing of the 15 μ carbon dioxide absorption band it should be possible to determine the location of temperature discontinuities of the order of 2° C at distances up to 20 miles. A small infrared Fabry-Perot spectrometer has been constructed to evaluate this technique. The spectral scan is from 13 to 15 μ with 0.10 μ resolution, and is accomplished by a piezoelectric drive which controls the separation of IRTRAN-4 Fabry-Perot plates. A more refined instrument, packaged for airborne use is under construction. Author

N65-33560 ARACON Geophysics Co., Concord, Mass.
RADIOMETRIC DETECTION OF CLEAR AIR TURBULENCE
Earl S. Merritt and Raymond Wexler *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 125–240 refs (See N65-33550 22-13)

The mesoscale nature of clear air turbulence (CAT) makes it unlikely that any technique developed from synoptic scale observations will prove generally effective to predict the occurrence of significant turbulent areas in the upper troposphere. Since the amount of radiant energy present in most spectral regions at the pressures and temperatures where CAT is a significant problem is limited, a spectral region is required which will provide detectable radiant energies within the state-of-the-art of radiometer technology. The following intevals are suggested: (1) the 2.7 micron region, containing strong CO_2 and H_2O bands, (2) the 6.3 micron H_2O band, and (3) the 15 micron CO_2 band. The emissivities of a representative turbulent cell and the transmissions of the intervening atmosphere at about 35,000 ft are evaluated in each of the suggested spectral intervals. From these evaluations, selection of an optimum spectral interval is accomplished. The selected interval will provide detectable energies within the state-of-the-art of infrared radiometric technology. Author

N65-33561 National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
NUMBUS HIGH RESOLUTION INFRARED MEASUREMENTS
I. L. Goldberg, L. Foshee, W. Nordberg, and C. E. Catoe *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 141–151 (See N65-33550 22-13)

Results from the Nimbus-I spacecraft indicate that radiative cooling of the detector cell to the desired temperature of −75° C was achieved within less than three hours of orbit time. Cooling remained stable thereafter. Excellent images of photographic quality of nighttime cloud structure and terrain features over many portions of the globe were obtained. Effective radiation temperatures within a range of 220° K to 320° K can be measured with a resolution of about 2° K. Author

N65-33562 Air Force Cambridge Research Labs., Bedford, Mass.

INFRARED MEASUREMENTS OF CLOUDS FROM A U-2 PLATFORM

F. R. Valovcin *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 153–172 refs (See N65-33550 22-13)

A research instrumented U-2 aircraft has been flown over and in various cloud regimes and synoptic situations. Aerial photographs have been taken simultaneously with infrared measurements in the 8–13 micron region. Measurements have been made over tornado producing thunderstorms, cumulonimbus cloud penetrations of the tropopause, Hurricane Ginny of 1963, and in and over cirrus clouds. Infrared instrumentation aboard the aircraft and representative infrared cloud measurements will be discussed. Author

N65-33563 RAND Corp., Santa Monica, Calif.

PATTERN RECOGNITION OF METEOROLOGICAL SATELLITE CLOUD PHOTOGRAPHY

Yale H. Katz *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 173–214 refs (See N65-33550 22-13)

This paper reports on some recent research which studied the quantitative characteristics of cloud patterns by determining common attributes of several pattern classes. Some mechanical procedures for automatically recognizing and classifying specific cloud patterns from satellite photography are described and several data reduction transformations that have detected and isolated characteristics in which cloud "streets" differ from randomly placed cloud elements are detailed. An approach to the problem of automatically determining global cloud cover from satelllite photography is also discussed. Author

N65-33565 Michigan Univ., Ann Arbor.

EARTH RADIATION MEASUREMENTS BY INTERFEROMETER FROM A HIGH ALTITUDE BALLOON

Lucian W. Chaney *In its* Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 225–244 refs (See N65-33550 22-13)

(Contract NASr-54(03))

The earth's thermal radiation was measured with an infrared interferometer (5μ to 15μ), 50 cm^{-1}. The platform used was a high altitude balloon which maintained a float altitude of 112,000 feet for eleven hours. The data obtained are discussed. Author

N65-33568 Atomics International, Canoga Park, Calif. Research and Advanced Development Div.

A CHEMICAL PROBE FOR THE MEASUREMENT OF ATOM CONCENTRATION PROFILES IN THE UPPER ATMOSPHERE

J. Greyson, R. T. Keen, and R. G. Ingalls *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 271–278 refs (See N65-33550 22-13)

(Contract AF 19(628)-4056)

The feasibility of wing freeze dried polymer aerogels as chemical probes for measuring nitrogen and oxygen atom concentrations in the upper atmosphere is investigated. Author

N65-33573 McGill Univ., Montreal (Quebec).

PHOTOGRAPHY OF THE EARTH FROM SPACE AND ITS NON-METEOROLOGICAL APPLICATIONS

A. Morrison and J. Brian Bird *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 357–376 refs (See N65-33550 22-13)

Photography from satellites and rockets constitutes a new source of information about the earth's surface. Advantages of space photography are that (a) an area hundreds of kilometers across can be shown in a single frame, (b) photographic tones are comparable, and a stero-effect is obtainable over this area, even if it is crossed by a political boundary, (c) uniform and frequent coverage of the entire earth can be obtained. Problems of light transmission through the atmosphere and of cloud cover are only a little greater than in aerial photography. Some existing space photography is usable, but a specially-designed system would yield better results. Apart from its illustrative value, space photography could assist in mapping: (a) relatively permanent distributions, e.g., geology, landforms, vegetation, generalized land-use, the extent of glaciers; and (b) ephemeral distributions, e.g., snow-cover, ice-cover on rivers, lakes, and the sea, forest fire burns, temporary lakes and streams, and ocean-water masses. Author

N65-33575 HRB-Singer, Inc., State College, Pa.

LINE-SCANNING RECONNAISSANCE SYSTEMS IN LAND UTILIZATION AND TERRAIN STUDIES

Thomas R. Ory *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 393–398 (See N65-33550 22-13)

A dual channel line-scan reconnaissance system offers new possibilities for the automatic in-flight separation of certain terrain features from complex backgrounds. The output from this system consists of a normal line-scan image printed beside the separated image so that a line-by-line correlation can be performed. The dual channel system also has the capability for the simultaneous analysis of terrain in two spectral regions. The results of recent studies involving terrain analysis with line-scanning remote sensors are discussed and predictions of future applications in this field are presented. Representative imagery of a variety of terrain features is presented for discussion. Author

N65-33576 Air Force Cambridge Research Labs., Bedford, Mass.

AERIAL RECONNAISSANCE OF SURFACE FEATURES WITH THE MULTIBAND SPECTRAL SYSTEM

Carlton E. Molineux *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 399–422 (See N65-33550 22-13)

A unique airborne spectral camera and data reduction system has been developed for reconnaissance of terrain surfaces and especially for detecting manifestations of underground nuclear test activity. The system operates in the 0.35 to 5.0 micron region of the visible and near-infrared spectrum. The airborne system consists of a 9-lens multiband camera, associated color reference cameras, a dual spectrometer system, cartographic camera, and skylight recording camera, flown in C-130 aircraft. Details of equipment, system operation, and processing of the resulting imagery are discussed. Specialized color enhancement and printing techniques emphasize the spectral reflectivity differences on the film to enable analysis of surface effects. Ground spectral data are collected to assist the interpretation of aerial imagery significance. Photointerpretation of vegetation and geologic conditions by simultaneous photography in narrow spectral regions will be advanced by this system. Author

N65-33579 Acadia Univ., Wolfville (Nova Scotia).

RADAR AS A SURVEYING INSTRUMENT IN HYDROLOGY AND GEOLOGY

H. L. Cameron. *In* Mich. Univ., Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 441–452 (See N65-33550 22-13)

High-definition radar scope photography is investigated as a new means for studying the earth's surface. The radar is installed in an R.A.F. V-bomber and operated at approximately 41,000 feet; photographs of the scope are obtained at 5-minute intervals, providing adequate "stereo" overlap. The radar photos resulting from flights over Gaspe and Scotland are presented and discussed. Author

N65-33583 Army Cold Regions Research and Engineering Lab., Hanover, N. H.
THERMAL MAPPING OF YELLOWSTONE NATIONAL PARK
James H. Mc Lerran and Joseph O. Morgan (Mich. Univ., Ann Arbor) *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 517–530 refs Prepared jointly with Mich. Univ., Ann Arbor (See N65-33550 22-13)

The purpose was to conduct a preliminary study of the usefulness of infrared imagery over terrain with natural high-temperature contrasts, and to determine if subsurface thermal anomalies could be imaged if they are not evident by surface hydrothermal features. This paper presents imagery from several areas and demonstrates that infrared sensing is useful for mapping hydrothermal features. The results from this study indicate that new studies should be conducted using new state-of-the-art infrared scanners and detectors. Author

N65-33584 Cornell Univ., Ithaca, N. Y.
AIRPHOTO INTERPRETATION OF ENGINEERING SOIL IN TROPICAL ENVIRONMENT
Ta Liang *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 531–536 (See N65-33550 22-13)
(Contract AF 19(628)-291)

Soil formation and rock weathering processes peculiar to the tropics result in certain earth materials having engineering properties significantly different from those common in temperate areas. Detection of such properties from airphoto patterns is illustrated by examples showing major types of earth materials in Central America, Southeast Asia, Australia and tropical Africa. Current progress and problems in photo interpretation are indicated. Author

N65-33585 HRB-Singer, Inc., State College, Pa.
DETECTION AND LOCATION OF SUBSURFACE COAL FIRES
Ronald J. Slavecki *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 537–548 refs (See N65-33550 22-13)

An infrared reconnaissance system to test the feasibility of detecting and locating subsurface coal fires on infrared imagery is discussed. The infrared images reveal that significant surface radiation variations can be detected over coal refuse piles having subsurface burning, and inferences may be drawn regarding the status of the fires and their direction of travel. Author

N65-33588 National Bureau of Standards, Boulder, Colo.
CHARACTERISTICS OF SOIL AND VEGETATED SURFACES TO REFLECTED AND EMITTED RADIATION
David M. Gates *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 573–599 refs (See N65-33550 22-13)
(Grant NsG-715)

A surface may be viewed by reflected sunlight or by emitted thermal radiation. The reflected radiation will be determined by the spectral reflectance of the vegetation, the spectral quality of the incident sunlight, and the geometry of the plant canopy. These factors are each described for specific examples. The energy emitted by a plant canopy depends upon the plant temperature, which in turn is determined by the energy exchanged between the plant and its environment. Energy is exchanged by radiation, convection, and transpiration. The energy exchange process is described by means of examples. Finally the radiation exchange is described as a function of the crop canopy geometry. This is done in generalized form so that the reflected and absorbed radiation is estimated as a function of the canopy density. The work described here is fundamental for the interpretation of aerial reconnaissance pictures of vegetated surfaces. Author

N65-33590 California Univ., Berkeley.
THERMAL INFRARED IMAGERY AND ITS USE IN VEGETATION ANALYSIS BY REMOTE AERIAL RECONNAISSANCE
Robert N. Colwell and Don L. Olson (Tex. Instr., Inc., Dallas) *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 607–621 refs Prepared jointly with Tex. Instr., Inc., Dallas (See N65-33550 22-13)

This paper will consider the various kinds of useful information which military and civil experts can obtain regarding vegetation from the use of a thermal infrared mapping system which operates in the 7-15 micron band. Special emphasis will be placed on the value of this imagery when used in conjunction with imagery obtained in the visible, near infrared, and near ultraviolet portions of the electromagnetic spectrum. Author

N65-33591 Northern Forest Fire Lab., Missoula, Mont.
PRELIMINARY EXPERIMENTAL RESULTS WITH INFRARED LINE SCANNERS FOR FOREST FIRE SURVEILLANCE
Stanley N. Hirsh *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 623–648 refs (See N65-33550 22-13)

Effective forest fire control is dependent on timely and accurate surveillance information. Data gathered during three years of flight testing indicate that infrared line scanners hold promise for providing this intelligence when presently used visual methods are ineffective. Author

N65-33592 Idaho Univ., Moscow.
PORTABLE LOW COST DETECTOR FOR LATENT FOREST FIRES
Everett M. Baily and William R. Parish *In* Mich. Univ., Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 649–666 refs (See N65-33550 22-13)

The discovery ot latent forest fires in their early stages or of hangover fires during mop-up operations is of prime importance to the preservation of our timber and watershed resources. This paper discusses the design and construction of a simple to operate, portable, rugged and inexpensive infrared detector to accomplish the above objectives. Author

N65-33593 Michigan Univ., Ann Arbor. Inst. of Science and Technology.
MULTISPECTRAL DATA COLLECTION PROGRAM
D. S. Lowe, F. C. Polcyn, and R. Shay (Purdue Univ.) *In* its Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 667–680 Prepared jointly with Purdue Univ. (See N65-33550 22-13)
(Contract DA-36-039-SC-78801)

Two programs for generating multispectral reconnaissance imagery in the spectral region between 0.32-14 microns are discussed. In one program, around-the-clock simultaneous multispectral imagery of selected sites was obtained at two week intervals over a period of one year. In addition to conventional photography, imagery was obtained in the following

four bands: 0.32 to 0.38μ, 2.0 to 2.6μ, 4.5 to 5.5μ, and 8.2 to 14μ. In the second program, around-the-clock imagery was generated in twenty overlapping spectral regions during five periods which were selected to observe various phases of the growing vegetation cycle. This paper discusses the measurement programs, the airborne instrumentation, the ground measurements, and data handling and reduction.

Author

N65-33594 Michigan Univ., Ann Arbor. Infrared Lab.
QUANTITATIVE AIRBORNE INFRARED MAPPING
G. England and J. O. Morgan *In its* Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 681–690 (See N65-33550 22-13)

Gray scale variations or contrasts in aerial infrared imagery yield no quantitative information with regard to radiation or surface temperature. The difficulty of providing suitable calibration in the scanner and of evaluating atmospheric transmission are primarily responsible. A technique for calibration of the final imagery, employing quantitative radiometric measurements in combination with special electronic processing of magnetic tape recorded infrared scanner signals and densitometry, is under investigation. Direct use of tape recorded data permits evaluations of errors or nonlinearities due to cathode ray tube photography and variations in film processing. Author

N65-33601 Army Cold Regions Research and Engineering Lab., Hanover, N. H.
AIRBORNE CREVASSE DETECTION
James H. Mc Lerran *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 801–802 Prepared in cooperation with Mich. Univ. (See N65-33550 22-13) (Contract DA-27-021-ENG-4)

The feasibility of aerial detection of snow and ice crevasses by infrared sensing is discussed. A program conducted in the Arctic is reported in which the reliability of detection is marginal. Some crevasses were visible on conventional aerial photography while others found in the infrared were not. It was found that crevasses filled with drifting snow appear colder than adjacent areas but are not always detected by infrared. Environmental factors such as wind can erase the surface thermal contrast. C.T.C.

N65-33603 Michigan Univ., Ann Arbor. Inst. of Science and Technology.
INVESTIGATIONS OF MULTI-SPECTRAL IMAGE INTERPRETATION
R. R. Legault and F. C. Polcyn *In its* Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 813–821 ref (See N65-33550 22-13)

The use of spectrophotometric data is straightforward. The images contain spatial information. They do not allow one to compare radiant intensities between bands for a given object. In fact no absolute radiometric information is available. The available spectral information is the order of radiant intensities within a band and partial information about the radiance difference between objects within a band. Two preliminary approaches are being investigated. The first identifies spatially at least one object in the scene and using the spectrum of the identified object estimates the absolute spectra of the remaining objects. An example of this procedure is presented. The second approach uses the radiance order and radiance difference changes between bands to identify objects. A test case separating botanical from non-botanical objects is presented. Author

N65-33668# Society of Photographic Scientists and Engineers, Washington, D. C.
UNCONVENTIONAL PHOTOGRAPHIC SYSTEMS
[1964] 173 p refs Symp. held on 29–31 Oct. 1964; Jointly Sponsored by Bur. of Naval Weapons

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N65-33669 Keuffel and Esser Co., Hoboken, N. J.
THERMOGRAPHY: STATE-OF-THE-ART REVIEW
Robert Gold *In* Soc. of Phot. Scientists and Engr. Unconventional Phot. Systems [1964] p 1–52 refs (See N65-33668 22-14)

Various patents in the field of thermography, relating to photographic copying using a heat copying technique, are discussed. These include methods and machines, heat sensitive and chemical papers, papers with obscuring layers, photothermography, and some miscellaneous procedures. A patent bibliography is included, under such headings as thermographic machines, heat sensitive coatings with blushed or other obscuring coatings, chemical papers, two-sheet transfer methods, photothermographic coatings, and general methods of thermographic copying. M.G.J.

N65-33670 XEROX, Rochester, N. Y. Research and Engineering Center.
ELECTROSTATIC ELECTROPHOTOGRAPHY, 1964: STATE-OF-THE-ART REVIEW
George R. Mott *In* Soc. of Phot. Scientists and Engr. Unconventional Phot. Systems [1964] p 63–87 ref (See N65-33668 22-14)

The status of electrophotography is reviewed, with emphasis on those applications, processes, and devices which have reached commercial status. Brief summaries are included on document copying techniques; transfer and nontransfer type equipment; and signal recording from optical transducers, which includes facsimile, computer printing, and galvanometer recording systems. Tonal reproduction by cascade development, xeroradiography, and electronic components and circuits are also discussed. The possibilities of processes now in the laboratory stage are explored, with continuous tone, graphic display, xeroprinting, and new imaging methods mentioned as promising developments. M.G.J.

N65-33671 National Cash Register Co., Dayton, Ohio. Fundamental Research Dept.
PHOTOCHROMISM: STATE-OF-THE-ART REVIEW

H. Schwab and R. C. Bertelson *In* Soc. of Phot. Scientists and Engr. Unconventional Phot. Systems [1964] p 94–106 refs (See N65-33668 22-14)

In the state-of-the-art review on photochromism, it was pointed out that the mechanisms generally fall into one of six categories. These are: isomerization, tautomerization, dissociation into radicals, dissociation into ions, oxidation reduction, and excited state population. Some potential applications for such a light sensitive media, which require no development and are reusable, are also discussed. These include uses depending fundamentally on light sensitivity, on reversibility, and on specific color changes. A bibliography, which lists major reviews published on photochromism and/or phototropism, is also included. M.G.J.

N65-33672 Tecnifax Corp., Holyoke, Mass.
THE DIAZOTYPE PROCESS: STATE-OF-THE-ART REVIEW
D. P. Habib and G. R. Hodgins *In* Soc. of Phot. Scientists and Engr. Unconventional Phot. Systems [1964] p 113–136 refs (See N65-33668 22-14)

Historical development, chemistry, and applications of the diazotype photoreproduction system are reviewed to show the scope of the process. The systems are classified as the diazotype, diazo-reversal, diazo-thermography, vesicular, diazo-lithography, and the metal-diazo processes. The term "azography" is recommended for the first three processes as the image ultimately formed is an azo dye; in the remaining processes, a light-sensitive diazo compound is used, but the image formed is not a dye. The relative advantages of the dry and moist methods are compared, and the photochemical and light decomposition mechanisms of diazotype materials are discussed. The spectral distribution data on light sources in diazoprinters are tabulated; graphs also are included to depict spectral energy, absorption, and sensitivity. The principal applications of diazotype materials are briefly described under such classifications as technical printing; office systems; projectuals; microfilm; and graphic arts. M.G.J.

N65-33673 General Aniline and Film Corp., Binghamton, N. Y. Photo and Repro Div.
PHOTOPOLYMERIZATION: PRESENT AND FUTURE [STATE-OF-THE-ART REVIEW]
Steven Levinos *In* Soc. of Phot. Scientists and Engr. Unconventional Phot. Systems [1964] p 145–152 refs (See N65-33668 22-14)

A method by which continuous-tone images can be obtained with photopolymerizable compositions in the form of coated layers is described. A schematic is included to show the photographic step wedge, and the photopolymerizable coating on a transparent, subbed support. A patent literature review showed other potentially interesting photopolymerization systems. These included: (1) initiation of polymerization by diazonium compounds in an alkaline environment; (2) synthesis of color couplers containing polymerizable groups; (3) a graphic reproduction process in which the photopolymerizable layer contains polyethylene oxide, polyethylene glycol diacrylate monomer, anthraquinone as a free radical generating photoinitiator, and p-methoxyphenol as a thermal polymerization inhibitor; (4) photopolymerization with metal sulfide, selenide, and telluride catalysts; and (5) techniques to limit the adverse effects of oxygen. It was also pointed out that oxygen can play a vital role in chain reactions via photochemical autoxidation, and that such reactions are good candidates for the photopolymerization process. M.G.J.

N65-33726# Battelle Memorial Inst., Columbus, Ohio.
A STUDY OF REQUIREMENTS FOR ESTABLISHMENT AND OPERATION OF A TRANSDUCER INFORMATION CENTER Final Report, 15 Apr. 1963–14 Apr. 1964
W. E. Chapin, G. L. Mc Cann, and W. H. Veazie Wright-Patterson AFB, Ohio. Flight Dyn. Lab., Mar. 1964 14 p refs (Contract AF 33(657)-11083)
(G-6490; FDL-TDR-64-34; AD-460944)

Between 1959 and 1961, a committee was established in the Instrumentation Branch of the Aeronautical Systems Division to make an accurate assessment of the state of the art of telemetry transducers with respect to progress in telemetry systems. One of many conclusions reached by this committee was that a central organization was needed to collect and disseminate transducer information on a current basis. Battelle Memorial Institute contracted to determine essential requirements for the establishment and operation of a transducer information center to fulfill this need. The program was initiated by conducting a study of existing information centers to determine whether or not some such organization was active in disseminating transducer information. As a part of this study, letters of inquiry were distributed to approximately 200 researchers, users, and manufacturers of transducers. The replies to these inquiries helped define the types of service desired from a transducer information center, types of tranducer information needed for providing this service to the technical community, proper selection of storage and retrieval techniques, and the qualifications of technical personnel needed to process information and provide technical assistance. Author

N65-33763# Stanford Research Inst., Menlo Park, Calif.
GRAPHICAL DATA PROCESSING RESEARCH STUDY AND EXPERIMENTAL INVESTIGATION Quarterly Progress Report No. 7, 1 Jan.–30 Apr. 1965
Alfred E. Brain and John H. Munson May 1965 35 p
(Contract DA-36-039-AMC-03247(E))
(Rept.-19; AD-618567)

A calculation has been made of the positional errors arising from the simple plano-convex lens used as a collimator in the optical preprocessor. An extensive experimental investigation has been carried out on hand-drawn military map symbols. 405 slides were prepared and read by the 100-image preprocessor on three separate days, the intermediate 100-bit code word being recorded from the ternary buffer onto paper tape. A total of 3240 code words were recorded, and subsequent training and analysis tests were made via the tape rather than the preprocessor. A program simulating MINOS II was run in parallel to provide for comparing the results that would have been given by MINOS II if it had been operating perfectly. The following conclusions were drawn: (1) the reproducibility of the observed behavior was sufficient to yield meaningful results, (2) the data base was still too small for the training data to be fully representative of the test data, and (3) the particular choice of output codes had a substantial influence on the difficulty of training to a low error rate. Author

N65-33772*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
SEQUENTIAL MEASUREMENT OF MULTIDIMENSIONAL TRANSDUCERS Technical Report No. 431
J. R. Sklar (Ph.D. Thesis) 29 Oct. 1964 89 p refs Lincoln Lab. Tech. Rept.-360
(Grants NsG-334; NsG-496; NSF GP-2495; Contracts AF 19(628)-500; DA 36-039-AMC-03200(E))
(ESD-TDR-64-567; AD-615515) CFSTI: HC $3.00/MF $0.75
CSCL 14B

Although the problem of decoding tree-encoded messages in communications and that of measuring the parameters which describe a multidimensional transducer appear very different at first, striking similarities arise upon closer scrutiny. These similarities are most evident when each successive transducer output depends on an additional transducer parameter. Because of these similarities and because sequential decoding has been so successful in decoding tree-encoded messages, a study of the application of sequential decoding algorithms to measurments was undertaken. This report analyzes a sequential algorithm suggested by R. M. Fano, Massachusetts Institute of Technology, and describes its application to measurement problems. From the analysis, bounds to the average number of computations needed to estimate one parameter are obtained. A bound is also derived for the probability of estimating at least one parameter of a set incorrectly. It will become apparent that when an attempt is made to differentiate between parameter values that produce too small an effect on the output, relative to the noise, the sequential method will fail. This difficulty determines a limit to the precision obtainable with the sequential method. This critical level may be likened to the computational cutoff rate in the corresponding communication problem.
Author

N65-33797# Data Corp., Dayton, Ohio. Systems Engineering Dept.
W-PAFB RECONNAISSANCE MULTISENSOR TARGET RANGE Interim Engineering Report No. 1, 1 Jul.–31 Sep. 1964
William L. Huck and Eugene R. Heath 30 Nov. 1964 43 p
(Contract AF 33(615)-1433)
(IER-64-8; AD-463459)

The design and construction of a multisensor reconnaissance test range, consisting of fully instrumented static analysis targets for the comprehensive test and evaluation of airborne photographic, infrared, and side looking radar reconnaissance sensors, are described. The individual target arrays represent a research effort in new evaluation techniques and target concepts heretofore untried. They were designed to yield a more meaningful measurement of system performance, and are expected to be instrumental in establishing a basis for evaluation standards and technical comparisons of tri-sensor systems.
R.N.A.

N65-33920*# Brown (D.) Associates, Inc., Eau Gallie, Fla.
PHOTOGRAMMIC CALIBRATIONS OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION ROSMAN #1 85-FOOT PARABOLIC ANTENNA IN STATIC AND DYNAMIC MODES (AXIS AT 70-DEGREE ZENITH DISTANCE)
Mak L. Mannen 29 Jun. 1965 115 p refs *Its* Rept.-17
(Contract NAS5-9783)
(NASA-CR-64881) CFSTI: HC $4.00/MF $0.75 CSCL 08B

Results are given for one static and two dynamic photogrammetric calibrations on a parabolic antenna. Nominal orientation of the antenna for all calibrations was 270 degrees from north at a zenith distance of 70 degrees; and raw data for each calibration were two photographs of the antenna taken simultaneously from two ground stations with special 480 mm focal length metric cameras. A synopsis of the key results for each of the calibrations is given, contact prints of the photographic plates are included, and diagrams of target point distribution on dish surface and feed structure are presented. Vector plots are made of perpendicular departures of photogrammetrically triangulated target points from best fitting paraboliid of revolution. Contour maps of error surface are shown. Other tabulated data include focal length and vertex of best fitting paraboloid of revolution, and transformed target point coordinates and component residuals of each dynamic calibration referenced to the corresponding coordinates of the static calibration.
M.W.R.

N65-33930# Kernforschungszentrum, Karlsruhe (West Germany). Institut für Angewandte Kernphysik.
A VERY FLEXIBLE PULSED BEAM SPECTROMETER FOR STUDYING NEUTRON SCATTERING IN SOLIDS AND LIQUIDS
F. Carvalho, G. Ehret, W. Gläser, and H. Ripfel Oct. 1964 8 p refs Presented at the IAEA Study Group Meeting on Res. Reactor Exptl. Tech., Bucharest, Oct. 1964
(KFK-263) CFSTI: HC $1.00/MF $0.50

The pulsed beam spectrometer for studying liquids and solids by neutron scattering is described. Its arrangement is similar to that of a normal crystal monochromator, a set of Soller type collimators being mounted in front of and behind the single crystal. The crystal rotates at high speed so that the Bragg law will be fulfilled in each revolution only during very short time intervals. Energy resolution and time width of the neutron pulse are determined by several parameters: collimation, geometrical dimensions and mosaic spread of the crystal, and its speed of rotation.
W.M.R.

N65-33933# International Business Machines Corp., Rockville, Md. Federal Systems Div.
OPTIMIZED DIGITAL AUTOMATIC MAP COMPILATION SYSTEM Interim Report, Feb. 10, 1963–Feb. 10, 1964
10 Mar. 1964 169 p refs
(Contract DA-44-009-AMC-111(X))
(IR-4; AD-600117)

In order to use digital techniques to produce orthophotos and contour maps to specifications approaching national standards, optimization of computer programs and systems hardware was undertaken and alternate computer correlation programs were developed. Improvements in the scanning equipment included repackaging of control logic, analog circuitry, control panels, and panel assemblies, improvements in air conditioning system and photomultiplier tubes; introduction of a light intensity monitor and facilities to eliminate ambient light leakage; and installation of new deflection circuitry and nonlinear amplifiers. Improvements in actual programming were concerned with rectification and orthocorrection, correlation techniques for various levels of the operation, application of simulated stereo data for development and testing of the correlation processes; and a predictive logic system. Rectification, correlation, relief displacement, contouring, and tic mark placement are unified into one program of the logic system. A second program in the logic system produces the orthophoto directly from the scanned photo data.
M.W.R.

N65-33971*# American Machine and Foundry Co., Alexandria, Va.
AN EXAMINATION OF THE AMES PROTON ANALYZER FOR PHOTON SENSITIVITY Final Report
Apr. 1965 12 p
(Contract NAS2-2475)
(NASA-CR-67078) CFSTI: HC $1.00/MF $0.50 CSCL 14B

A proton analyzer, designed to determine the energies of positive ions emanating from the sun by cycling energies through 15 channels each sensitive to ions of a portion of the total energy range, was tested for sensitivity by bombarding it with photons of three different wavelengths with fluxes corresponding to those produced by the sun. During the bombardment, the orientation of the analyzer was changed and the output measured as a function of the azimuth and elevation angles, and wavelength. Channels 2 through 14 responded to all sources with from 0.25 to 0.75 volts. A Lyman alpha source appeared to

saturate channel 15. When the orientation was changed the response of the analyzer dropped off rapidly. With Lyman alpha as the source, the azimuth and elevation angles were changed in 12.5° increments. R.N.A.

N65-33974*# Schjeldahl (G. T.) Co., Northfield, Minn. Advanced Programs Div.

THEORETICAL STUDY AND ENGINEERING DEVELOPMENT OF JIMSPHERE WIND SENSOR Final Report, 27 Feb. 1964–1 Jun. 1965

Clinton V. Eckstrom Jul. 1965 92 p
(Contract NAS8-11158)
(NASA-CR-64966) CFSTI: HC $3.00/MF $0.75 CSCL 14B

Jimsphere Wind Sensor balloons of 2-meter diameter having various sizes, shapes, and quantities of roughness elements (projections) molded into the balloon material, have been fabricated and flight tested to determine the optimum design for control of flow separation and stabilization of the sphere wake. The Jimsphere wind sensing balloon reaches an altitude of approximately 18 kilometers within one hour. Wind tunnel tests have been conducted to determine the drag coefficient of a model Jimsphere and full-scale tests were conducted to determine the apparent mass factor for the Jimsphere configuration. A considerable discrepancy exists between the drag coefficients determined from flight data and those determined in the wind tunnel. No explanation is given for this difference. Theoretical investigations of the Jimsphere have concerned development of the equations of motion which include effects of apparent mass and wind accelerations, determination of wind response capabilities and wind gradient error factors due to wind response lag. Author

N65-34018# Rensselaer Polytechnic Inst., Troy, N. Y. Winslow Labs.

DEVELOPMENT OF SOIL PRESSURE GAGES

Emmericus C. W. A. Geuze and Robert Y. K. Cheng Mar. 1965 142 p refs
(Contract NBY-32240)
(AD-466091)

This report describes a soil pressure measuring system which involves quick-freezing a zone of soil in the "free-field," excavating a cavity in the frozen zone, suspending a triaxially sensitive pressure gage in the cavity, and surrounding the gage with a liquid which changes to an elastic solid before the soil thaws. An auxiliary procedure is determination of in-situ soil stress-strain properties in thawed cavities carved from frozen zones surrounding the point at which future pressure measurement will be made. A triaxilally sensitive spherical gage was developed and tested. Equipment for freezing a zone of soil was tested, and a cavity trimming tool was successfully used. Suitable room-temperature-vulcanizing silicone rubber compounds were formulated which would solidify in the frozen environment. A concept was developed, but not tested, for a device to perform the auxiliary determination of soil stress-strain properties. Also included in the report is a brief review of soil pressure measurement techniques. Author

N65-34091# General Dynamics Corp., San Diego, Calif. General Atomic.

RADIATION EFFECTS ON PRESSURE TRANSDUCER COMPONENTS Final Report, 1 Dec. 1964–28 Feb. 1965

R. A. Poll, L. D. Cotter, D. F. Jackson, and V. A. J. van Lint Kirtland AFB, Ohio, AF Weapons Lab., Jun. 1965 103 p
(Contract AF 29(601)-6692)
(GA-6266; AFWL-TR-65-49; AD-618073)

The performance of two types of pressure transducers and several cables in a radiation environment has been evaluated by an experimental program. The transducers were (1) a quartz piezoelectric crystal assembly, and (2) several strain-gauge transducers made by the Stanford Research Institute. The most important perturbations of these transducers by a short pulse of radiation are the emission and absorption of secondary electrons by parts of the device and the conductivity of insulating materials, including quartz, cable connectors, and cables. The experimentally measured results can be applied to evaluate the spurious signals and the perturbation of pressure-induced signals in a specified pulse radiation environment. The experimental program also included the evaluation of several zener diodes, Shockley diodes, and silicon controlled rectifiers. These devices are to be used in a pulsed power supply which will also be exposed to a pulsed radiation environment. The most important determinations for the SCRs and the Shockley diodes were the gamma levels required for complete turn-on and the neutron levels which would cause failure of these devices. Author

N65-34106# California Univ., Berkeley. Lawrence Radiation Lab.

A PRECISION TECHNIQUE FOR MEASURING AZIMUTHAL DISTORTION IN OPTICAL LENSES

Jack Hohenstein and Duane Norgren 14 Jul. 1965 13 p ref
(Contract W-7405-ENG-48)
(UCRL-16260) CFSTI: $1.00

Apparatus and techniques were developed for accurately measuring azimuthal distortion in camera lenses. Great care was taken in fabricating the camera, which was made cylindrical so that the lens could be rotated. The experimental setup included a collimating telescope, the cylindrical camera containing the lens to be tested, and the test pattern. By rotation of the cylindrical camera, the same portion of the test pattern could be used for checking azimuthal distortion in different sectors of the lens. The distortion was recorded on film plates, which were then measured with a linear micrometer. Results were obtained to an accuracy of 1 part in 100,000. Author

N65-34111# Bureau of Reclamation, Denver, Colo. Hydraulics Branch.

INVESTIGATION OF THE EFFECT OF TURNOUT GEOMETRY ON THE REGISTRATION ACCURACY OF A PROPELLER-TYPE OPEN FLOWMETER

C. E. Brockway 28 May 1965 18 p
(HYD-545; AD-466569)

Measurement of the indicated discharge of a 12-in. propeller-type open flowmeter in laboratory tests showed that the deviations caused either by the change in outlet geometry or by the change in submergence of the outlet pipe did not exceed the normally specified meter accuracy of + or −2%. Calibrations were made for 2 water depths in each outlet type to study the effect of submergence on the indicated discharge. Over the rated range of discharges (0.45 to 4.5 cfs) the difference in indicated discharge for the 2 outlets was less than 1.7% with the maximum deviation occurring at the lowest discharge (0.45 cfs). The maximum variation in indicated discharge caused by an increase in submergence of the outlet pipe of 1.3 pipe diameters was less than 0.6% for the open box and less than 2.0% for the farm turnout. The effect of changes in submergence of the outlet on indicated discharge is not significant, as indicated by best-fit calibration curves, provided that the turnout pipe exit remains fully submerged. The farm turnout tested is probably the minimum size that should be used, because any decrease in outlet well size would cause increased turbulence in the canal section and could cause erosion of the downstream embankment. Author

N65-34167# Army Electronics Labs., Fort Monmouth, N. J.
AIRBORNE ELECTRIC FIELD MILL (MECHANICAL ASPECTS)
John H. Kwik, Jr. May 1965 27 p ref
(ECOM-2589; AD-619417)

The airborne electric field mill is an electro-mechanical device which is externally mounted on an aircraft and is used to measure the strength of electric fields in the atmosphere and the direction relative to the line of flight from which they originate. This instrument has been used with excellent results in the atmospheric physics research program related to thunder storms. The mechanical design was discussed. Fasterners such as screws, rivets, welds, etc., could not be used on any exterior surface above the base mounting plate. Discussed also was the slip ring brush assembly and how it was modified to acquire the specified rectification; the phase shifting and grounding functions; the motor and power transmission system used to drive the rotor; the bearings and lubricants used; the weather-proofing methods and devices employed; the necessity for the acquisition and maintenance of dynamic balance in the rotor; and the tests performed during development to acquire confidence in the design. Author

N65-34181# Air Force Cambridge Research Labs., Bedford, Mass. Space Physics Lab.
A UNIQUE SCINTILLATION RATE COUNTER FOR IONOSPHERIC STUDIES Instrumentation Paper No. 71
Frederick F. Lack and John P. Mullen Jun. 1965 17 p refs
(AFCRL-65-469; AD-619807)

A device is described which will measure the scintillation rate of a radio signal within the range of 0 to 30 cps and read out its count in analog form every 10 sec. The counter is a simple and compact transistorized device which contains its own calibration standard. The theory of operation is described. The counter's performance is checked with a laboratory Rayspan spectrum analyzer. The application of the counter to the study of ionospheric irregularities by satellite-borne beacons is discussed. It is shown that under certain conditions the device may be used to measure ionospheric irregularity size. Author

N65-34208# Harry Diamond Labs., Washington, D. C.
ALTIMETER FOR REENTRY VEHICLE Design Proposal
Robert S. Goodman 1 Jun. 1965 39 p
(HDL-TM-65-29; AD-618225)

This report describes a proposed design of an altimeter system to give reentry altitude data and height-of-burst information. The intended application of the proposed system requires a missile-borne altimeter that is similar to the pulse-radar ranging device developed by HDL for the Pershing missile. The associated data acquisition station (DAS) must be capable of operating either ground based or airborne. Operation of the system proposed requires simply a transmitter and transponder contained in the reentry vehicle and a DAS located in either an airplane or surface station. The altitude data are recorded in digital form, together with an analog record of TM data. The record information is processed later by a computer. The design is based on a 40-ft system accuracy requirement and not on component limitation. Feasibility of the design concept has been proved in five flights under Pershing missile environment. The accuracy of the Pershing altimeter was approximately ±15 ft. Author

N65-34216*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RANGER PHOTOMETRIC CALIBRATION
G. M. Smith and D. E. Willingham 15 Aug. 1965 13 p
(Contract NAS7-100)
(NASA-CR-64974; JPL-TR-32-665) CFSTI: HC $1.00/MF $0.50 CSCL 14E

An equation is derived which relates collimator luminance values as read with a Pritchard photometer to actual lunar scene luminance values, such that identical Ranger camera response occurs. The solution of this equation requires detailed knowledge of emission spectra of the Moon, the collimator, and a calibration standard and the spectral response characteristics of the "standard eye," the photometer, and each specific vidicon camera. Calculations are made for six typical Ranger cameras, and variations in the results from camera to camera are noted. Author

N65-34274# Geophysics Corp., of America, Bedford, Mass. Technology Div.
ELECTRON/ION DENSITY INSTRUMENT PACKAGES FOR HIGH ALTITUDE GUN PROBES Monthly Progress Letter Report, Apr. 1965
4 May 1965 4 p
(Contract DA-19-020-AMC-00292(R))
(MPLR-17; AD-464465)

A ramp generator circuit was designed to eliminate all unijunction transistors and to be incorporated in future ac probes. The ramp generator consists of a constant current circuit, capacitor, current detecting transistor, and reset transistor. Two other transistors along with two resistors form a low impedance voltage source for the negative supply of the ramp; these transistors minimize the amount of current being drawn from the −7V battery. Another transistor is used as an emitter follower and serves to reduce the loading on the negative capacitor. Two additional resistors form a voltage divider which limits negative excursion at the base of another emitter follower transistor to −3.2V; this transistor with two resistors forms a divider to limit positive excursions of the ramp to +2.7V at the output. The new ramp generator has been operated continuously for three days and has been temperature cycled several times with no signs of malfunction or deterioration. It is considered more reliable than a previously developed ramp because of the elimination of unijunction transistors. M.W.R.

N65-34323# Oak Ridge National Lab., Tenn.
APPLICABILITY OF A LARGE-SURFACE METHANE FLOW COUNTER FOR THE DETECTION OF PERSONAL CONTAMINATION
W. G. Rudat and M. W. Strötges [1965] 8 p refs Transl. into ENGLISH from Atompraxis (Germany), v. 10, no. 11, 1964 p 469–472
(ORNL-TR-595)

Studies were conducted on the possibility of detecting soft beta emitters, such as carbon 14, sulfur 35, and strontium 90, with the large surface methane flow counter type DDD 700 in personnel externally contaminated. The studies confirmed that sufficiently accurate information on the value of external radioactive contamination can be obtained even under the relatively uncertain geometric conditions existing in persons affected by a radiation accident, and that the high sensitivity of the DDD 700 permits the detection of very low activities. R.N.A.

N65-34346# Atlantic Research Corp., Alexandria, Va. Electro-Mechanics Div.
THE DEVELOPMENT OF THE HORIZONTAL SEISMOMETER
L. H. Washington Jul. 1965 21 p
(Contract DA-36-034-ORD-3116-RD)
(TR-PL-8494; AD-468840)

A horizontal seismometer, to record horizontal displacements of ±6 inches, is described, and the results of a field test of the instrument 200 feet from the detonation of 500 tons of high explosive are given. Recommendations are made for modifications and further testing. Author

N65-34393*# Adcole Corp., Waltham, Mass.
ELECTRONIC INSTRUMENTATION FOR IONOSPHERIC AND EXTREME ULTRAVIOLET RADIATION MEASUREMENTS Final Report
Robert S. Hills 1 Mar. 1965 159 p refs Sponsored in part by NASA
(Contract AF 19(628)-2464)
(NASA-CR-67047; AFCRL-65-417; AD-618293) CFSTI: HC $5.00/MF $1.00 CSCL 14B

This report describes the design, construction, test and flight use of the electronic portions of research instruments used on rockets and satellites for the investigation of ultraviolet solar radiation. These instruments include grating monochromators for measurements in the 55–1300 Angstrom range and proportional counter spectrometers in the 1–10 Angstrom range. Also described is work done on retarding potential analyzers used for analysis of environmental charged particles, including measurement of electron temperature. All the instruments are of a telemetering type. Associated equipment used for calibration and testing of the instruments in both the laboratory and the launch phases is described. Automatic data reduction equipment was developed and used successfully. Experiments involved OSO, OGO and Air Force satellites and Aerobee-150 and Black Brant rockets. Author

N65-34395*# Southern Reseach Inst., Birmingham, Ala.
THE DEVELOPMENT OF GRAPHITE SENSING ELEMENTS FOR SLUG CALORIMETERS AND A HIGH TEMPERATURE BLACKBODY SOURCE Final Report
26 Jul. 1965 148 p refs
(Contract NAS8-5196)
(NASA-CR-67043) CFSTI: HC $4.00/MF $1.00 CSCL 20M

A graphite sensing disc for use in slug type calorimeters, and a blackbody radiation source with a 1-inch diameter aperture and an output irradiance of 100 Btu/ft^2/sec are under study. One prototype calorimeter was designed, fabricated, and calibrated. The unit closely approximates anticipated flight units in design and performance. During calibration, the sensing element temperature was taken to a maximum 2300° F over a range of heat flux densities from 40 to 90 Btu/ft^2/sec. Results of this calibration indicated excellent repeatability and consistency. A blackbody was constructed of graphite, inductively heated, and calibrated over a range of temperatures from 2000° to 4100° F. The range varied from 1/4 inch to 12 inches. The blackbody performed well at heat flux densities up to 100 Btu/ft^2/sec. Considerable effort was given to the design of the cavity and induction coil, so that the thermal gradients within the cavity were reduced to a minimum. R.W.H.

N65-34408*# Lockheed-California Co., Burbank.
STUDY OF HIGH RESOLUTION WIND MEASURING SYSTEMS. PHASE II: ANALYSIS
Fox Conner, W. W. Hildreth, Jr., Edward V. Ashburn, and H. A. Thorpe 19 May 1965 63 p refs *Its* Rept.-18832
(Contract NAS8-11286)
(NASA-CR-67138) CFSTI: HC $3.00/MF $0.75 CSCL 04B

Reported is a study of high resolution wind measuring systems. Improved wind measuring systems will aid the design of space boosters by obtaining data of higher resolution on the random and regular features of the wind environment. For this purpose, a resolution of 25 m is desired in the wind profile at altitudes up to 20 km. A comparative analysis was conducted which showed five types of systems appearing to be worthy of further research and development; these systems were (1) an uninstrumented wind probe with precision tracking radar; (2) an instrumented probe; (3) a chaff column system with multistation Doppler radar; (4) a smoke trail system with precision cameras; and (5) a sonic system. The comparative analysis was preceded by analyses of optical, wind-sensor and sonic wind measuring systems. The completion of these analyses aided in comparing the potential of these three systems with other types. Author

N65-34414*# Raymond Engineering Lab., Inc., Middletown, Conn.
1 × 10^7 BIT MAGNETIC TAPE RECORDER DEVELOPMENT Final Report
Bryant B. Besse 17 Dec. 1963 137 p Prepared for JPL
(Contracts NAS7-100; JPL-950105)
(NASA-CR-67061; REL-618) CFSTI: HC $4.00/MF $1.00 CSCL 14C

A prototype of a 1 × 10^7 bit magnetic tape recorder, with four record speeds and four synchronous playback speeds, was developed. Playback rates are 84, 168, 336, and 672 bits per second; and an endless tape loop with 700 feet of tape is used. A breadboard system of the transport and playback amplifier was developed and the components for the final prototype assembly were fabricated; specific circuits and subsystems were breadboarded in a table-top rack cabinet; and extensive tests were made of the breadboard electronic system. Considerable flexibility was designed into the recorder since its use in the spacecraft would require playback of a block of data without disturbing previously recorded information. A slew or fast forward mode was built into the recorder to facilitate scanning, and an end-of-tape sensor was provided. The 10^7 bit recorder has a power consumption of 2.5 to 4.6 watts on playback and from 2.7 to 4.8 watts on record. Recorder weight is 11.66 pounds without shock mounts which bring its weight up to 13.2 pounds. Overall size is 300 cubic inches. M.W.R.

N65-34443# Federal Aviation Agency, Atlantic City, N. J. Systems Research and Development Service.
INVESTIGATION OF A TIME-FREQUENCY TECHNIQUE FOR RANGE AND RANGE-RATE MEASUREMENTS
A. J. Mantwilla and Karl Burkard May 1965 50 p
(RD-65-54; AD-618423)

A flyable breadboard device utilizing a stable atomic clock to derive range and relative closing speed of two aircraft was built. The ratio of range and relative closing speed is used to approximate time to nearest approach (tau) for assessing collision threats. An analysis of the results indicated that the technique is a feasible method of determining range and relative closing speed (range rate) and is applicable to assess airborne collision threats. Author

N65-34451# Stanford Research Inst., Menlo Park, Calif.
FIELD TESTING OF INSTRUMENTS FOR MEASUREMENT OF DUSTY AIRBLAST EFFECTS Final Report (Phases VI and VII), 1 Jun. 1964–15 Jun. 1965
T. D. Witherly 15 Jun. 1965 70 p refs
(Contract DA-49-146-XZ-024)
(DASA-1671; AD-467533)

Newly developed airblast instrumentation and a surface shear gage were field-tested for the first time in a 500-ton surface TNT detonation (Operation Snowball). Above ground measurements of dynamic pressure of the air, dust momentum flux and drag on a cylinder, and sub-surface measurements of shear stress in the soil were made at four distances from ground zero. Dynamic pressure and dust momentum flux were measured at each station by a single gage designed to measure these two blast wave parameters independently. Reasonable results were obtained from the total drag gages and a drag coefficient of 2.0 is indicated (based on clean air dynamic

pressure). Shear stresses in the ground due to the airblast were of the order of one-fiftieth the observed overpressure, much less than anticipated. Author

N65-34456# California Univ., Livermore. Lawrence Radiation Lab.
ALPHA AIR MONITOR WITH CONSTANT FLOW CONTROL
E. B. Beard and K. F. Petrock 30 Jun. 1965 14 p ref
(Contract W-7405-ENG-48)
(UCRL-14253) CFSTI: $1.00

A continously indicating alpha air monitor featuring a solid-state constant flow control is described. A transistorized detection circuit provides a 30-day record of collected activity. Author

N65-34459# Federal Aviation Agency, Atlantic City, N. J. Systems Research and Development Service.
FEASIBILITY STUDY OF AIRBORNE TACAN INTERROGATOR MODIFICATIONS TO REDUCE FALSE SECTOR LOCK-ON Final Report
Bernard Weinstein, John Walls, Carl Trout, and Henry Hurley Ju. 1965 19 p
(RD-65-82; AD-618415)

A feasibility study of airborne TACAN interrogator modifications to reduce false sector lock-ons has been conducted. Two different types of circuit modifications were investigated: In one type, called Modification No. 1, the 15-cps gate-width was limited to a maximum of ±10 degrees. This allowed the 15-cps error to be as much as ±10 degrees without causing any error to be indicated on the Course Deviation Indicator (CDI). In Modification No. 2, the 15-cps gate-width was limited to a maximum of ±20 degrees. This allowed the 15-cps error to be as much as ±20 degrees without causing the servo motor to go into the search condition. Author

N65-34503*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
PRELIMINARY CONSIDERATIONS OF OPTICAL TELESCOPES FOR LUNAR SURFACE USE
Ernest H. Wells Washington, NASA, Oct. 1965 33 p refs
(NASA-TN-D-3003) CFSTI: HC $2.00/MF $0.50 CSCL 14C

In addition to describing the various types of astronomical reflecting telescopes and their diverse characteristics, the relationships between mirror sizes and capabilities are shown. Since the resolution on Mars decreases with mirror sizes up to 200 inches, a 21-inch porthole folded-optics telescope was considered for an early lunar mission. The presented design will give a 50 percent decrease in resolution over current earth-based instruments, and powers up to 1050 to provide maximum spectral coverage in ultraviolet and infrared regions. G.G.

N65-34551# IIT Research Inst., Chicago, Ill. Technology Center.
ANALYSIS OF OPTICAL WAVEFRONT DISTORTIONS CAUSED BY THE ATMOSPHERE Interim Technical Report, 21 Apr.–20 Jul. 1965
Anthony J. Montgomery 30 Jul. 1965 61 p refs
(Contract AF 33(165)-2429)
(IITRI-A6121-6; AD-468153)

Preliminary experiments using a pointing interferometer were considered to obtain the optimum design of a wavefront shearing interferometer to measure optical wavefront distortions caused by the atmosphere. Using a pointing interferometer allows the shape of wavefront along the line of flight to be determined. A pointing interferometer, which can be modified to measure wavefront distortion, was constructed and preliminary measurements indicate that the technique could be used to measure changes in orientation of the wavefront of less than one arc second. The construction of a pointing interferometer for use in flight tests appears to be feasible. Interferograms of wavefront distortion, caused by artifically produced local air turbulence, indicate that distortion is absent over some short time intervals. There would be no image degradation due to the turbulence if the film were exposed during one of these intervals. The wavefront distortion is shown to be much greater when the region of turbulence is in the vicinity of the interferometer as compared to near the source. R.N.A.

N65-34567# Stanford Research Inst., Menlo Park, Calif.
AN IMPROVED SONIC ANEMOMETER-THERMOMETER Final eport
S. Oleson Aug. 1965 38 p refs
(Contract DA-36-039-AMC-03713(E))
(AD-619996)

A prototype sonic thermometer has been developed for use in conjunction with a sonic anemometer. The sonic thermometer was developed to furnish an analog signal representing air temperature and to automatically provide a correction to the sonic anemometer's representation of the horizontal windspeed for error due to temperature changes in the air. A portion of the sensing probe for the sonic anemometer identically serves as the sensing unit for the temperature measurement. The sonic thermometer utilizes signals from the transmitter and from each of two diametrically opposite receivers located in the horizontal plane. In the design analysis, consideration was given to temperature measurement errors arising from sources such as air velocity, air pressure and humidity fluctuations, theoretical approximations, and stability of the measuring instruments. The absolute accuracy of the sonic thermometer is approximately within one degree Kelvin. Resolution is approximately 0.05° K. Author

N65-34609* United Nuclear Corp., White Plains, N. Y.
A GAMMA-RAY PROBE SYSTEM FOR DETERMINING THE SHIELDING EFFECTIVENESS OF THE APOLLO VEHICLE
A. D. Krumbein, R. C. Ross, and C. Beaulieu *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 257–262 ref (See N65-34575 22-29) GPO: $3.25 CFSTI: MC $2.50
(Contract NAS8-5252)

A gamma ray probe technique to determine the shielding effectiveness of any given material configuration against proton radiations likely to be encountered in space has been devised and tested. The essence of the technique is the use of gamma ray attenuation measurements to determine the areal electron densities along a great many paths through the configurations to be tested. A computer code is then used to calculate the proton dose received behind these configurations from typical space proton spectra. The basis of the gamma probe technique is reviewed, and a semiautomatic system designed to determine the shielding effectiveness of the Apollo command and service modules is described. This system is capable of obtaining data at as many as 10 dose points inside the module simultaneously. Additional applications of the gamma probe technique are mentioned. Author

N65-34708# Cubic Corp., San Diego, Calif.
SHIRAN GEODETIC SURVEY SYSTEM, ELECTRONIC AN/USQ-32(XA-1) Technical Report, 28 Feb. 1962–Oct. 1964
Wright -Patterson AFB, Ohio, Systems Eng. Group, Apr. 1965 108 p
(Contract AF 33(657)-7548)
(FTR/21-2; SEG-TR-64-72; AD-618063)

A full description of the system and equipment is given for a geodetic survey system, known as SHIRAN. The operation of the equipment is explained at the block diagram level. Also described are the rf equipment items and the modifications made to the SHIRAN equipment to enable its use in the AN/USQ-28 program. The flight and environmental tests conducted on the developmental equipment are covered in detail. Line crossings were made over 15 lines connecting a six-station ground base network. These line measurements were mathematically reduced to geodetic distance and had a probable error of ±0.0011 nautical miles. The results of two photomapping flights showed that aircraft locations derived from reduced photographic data agreed within ±21.6 feet for 90 percent of the measurements. C.T.C.

N65-34709# Harry Diamond Labs., Washington, D. C.
ANALYSIS OF THE RESISTIVE LAYER TRANSDUCER
John L. Scales, III 15 Jun. 1965 21 p refs
(HDL-TM-65-5; AD-619226)

In a piezoelectric semiconductor, a surface layer of high resistivity material is driven by an alternating electric field, while the conducting substrate is mechanically coupled but not driven electrially. This analysis shows the response of the composite system, giving the behavior with frequency and effects due to loading. For reasonable (low) values of the attenuation constant, it is shown that the effect of the substrate is to lower the amplitude of vibration but leave the resonant frequency almost unchanged. An assumption, which limits the analysis, is that the proportionality constant between stress and rate of change of strain is independent of frequency. Author

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N65-33650*# Pressure Technology Corp. of America, Woodbridge, N. J.
RESEARCH STUDY OF THE DEFORMATION CHARACTERISTICS OF SEMI-BRITTLE MATERIALS UNDER ULTRA-HIGH HYDROSTATIC PRESSURES First Quarterly Report, Mar. 25–Jun. 25, 1965
20 Jul. 1965 50 p refs
(Contract NASw-1199)
(NASA-CR-64667) CFSTI: HC $2.00/MF $0.50 CSCL 13H

CONTENTS:

1. GENERAL, TECHNICAL, ANALYSIS, EXPERIMENTAL, RESULTS, AND FUTURE WORK 14 p refs
2. ACCOUNTING FOR STRAIN HARDENING AND STRAIN RATE EFFECTS IN FLUID-TO-FLUID (HYDROSTATIC) EXTRUSION B. Avitzur (Lehigh Univ.) 31 p refs (See N65-33651 22-15)

N65-33651* Lehigh Univ., Bethlehem, Pa.
ACCOUNTING FOR STRAIN HARDENING AND STRAIN RATE EFFECTS IN FLUID-TO-FLUID (HYDROSTATIC) EXTRUSION
B. Avitzur *In* Pressure Technol. Corp. of Am. Res. Study of the Deformation Characteristics of Semi-brittle Mater. under Ultra-High Hydrostatic Pressures 20 Jul. 1965 31 p refs (See N65-33650 22-15) CFSTI: HC $2.00/MF $0.50

A kinemetically admissible velocity field and the resulting extrusion pressure character characteristics, as solved earlier for non-strain hardening materials, are first presented again. Effective strain rates and effective strains are computed, and the effects of strain hardening and strain rate sensitivity on the process are evaluated. Author

N65-33681# Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center.
METALWORKING—REVIEW OF RECENT DEVELOPMENTS
T. G. Byrer 25 Sep. 1964 1 p refs
(AD-460863)

Hot-cold working, alloy extrusion, flo-forging, and incremental dieless forming are discussed in connection with developments in metal working. A comparison is included of tensile properties of materials formed by conventional techniques and by hot-cold forging, and columbium and titanium alloys are considered. M.W.R.

N65-33695# Solar, San Diego, Calif.
BASIC METALLURGY OF DIFFUSION BONDING Interim Technical Documentary Progress Report No. 3, 15 Nov. 1964–15 Feb. 1965
J. S. Dunning 10 Mar. 1965 30 p ref
(Contract AF 33(615)-1681)
(RDR-1442-3; AD-464986)

Continued research conducted under a program designed to study inherent problems associated with the use of the diffusion bonding technique in which intermediate materials are used to facilitate bonding, is reported. Focused on is the development of a joining process which will allow the use of refractory metals and superalloys in the construction of high performance, high speed, aerospace vehicles. Presented are data on the TD-nickel/60 palladium-40 nickel system. TD-nickel specimens were bonded at 2100° F, 10 ksi and 20 sec with 0.001 in 60Pd-40Ni foil. Included are data from room temperature tests of butt tensile, shear and double lap peel specimens. The tensile strength of as-bonded butt joints for all systems was determined at 2000° F. Joint strengths were high in all systems with the exception of the TD Ni/Pd-Ni systems where joint strengths of 5000 to 6000-psi were recorded. Although results are inconclusive, the use of thin intermediate foils tended to give higher joint strengths than the as-bonded condition. Diffusion studies were initiated in all systems. Presented are preliminary data on the effect of exposure to elevated temperature on diffusion bonded joints. S.C.N.

N65-33799# Illinois Univ., Urbana. Charged Particle Research Lab.
ELECTROKINETIC PUMPING OF INSULATING LIQUIDS
James Bao-yen Tsui 15 Jan. 1965 125 p refs
(Contract AF 33(615)-1459; Grant AF-AFOSR-107-64)
(CPRL-1-65; AD-463730)

Theoretical and experimental studies, and applications of the ion drag pump are considered. From the observation of the motion of liquid between the electrodes of the ion drag pump, a physical picture of the pump operation was assumed. Through the basic physical picture, another type of ion drag pump was suggested in which electric and magnetic fields were used. An analysis of this pump was carried out. It proved to have better efficiency than the electric field pump. Since the pressure generated by the pump was low, it was used in limited cases. To break a cylindrical liquid jet into uniform size

droplets a small sinusoidal pressure variation was needed. Measurements of charge on the drops indicated that the ion drag pump influences the production of droplets without charging the drops. R.W.H.

N65-33907# Shell Oil Co., Wood River, Ill. Research Lab.
STUDY OF HELICOPTER GEAR LUBRICATION Quarterly Progress Report, Mar.–May 1965
D. R. Bailey and S. J. Beaubien [1965] 16 p refs
(Contract NOw-65-0323-c)
(QPR-1; AD-618522)

The effect of several gear surface precoatings on gear performance, and the gear performance of a typical synthetic, tetraester, five-centistoke base oil are investigated. It was found that precoating gears by heating in atmospheres of air, or a diester base oil, had little effect on the score load of a MIL-L-23699 test oil, while gears treated in a nitrogen atmosphere gave an increase in score load. Fatigue life as measured by the time to pitting failure, on the other hand, was considerably affected by the precoatings, particularly at high speed. In constant load tests at 6400 rpm it was found that the diester oil precoating extended gear life by a factor greater than seven, while the air precoating increased life three times. Under these same conditions the nitrogen treatment had no effect on gear life. While the coating techniques investigated represent only an initial attempt in this field, the improvement in performance is sufficient to warrant further study. From tests with the synthetic base oil, it was found that this oil is rather insensitive to break-in, and that fatigue failures occurred by fatigue-scoring rather than by pitting. Author

N65-33924*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN AND OVERALL PERFORMANCE OF AN AXIAL-FLOW PUMP ROTOR WITH A BLADE-TIP DIFFUSION FACTOR OF 0.66
Max J. Miller and James E. Crouse Washington, NASA, Sep. 1965 29 p refs
(NASA-TN-D-3024) CFSTI: HC $2.00/MF $0.50 CSCL 13K

A 9-inch-diameter axial-flow pump rotor with an 0.8 hub-tip radius ratio and a blade-tip diffusion factor of 0.66 was designed by blade-element techniques and tested in water. With this level of loading, a relatively high flow coefficient and a radial distribution of energy addition increasing from hub to tip were required. These design conditions were required to obtain a head-rise coefficient approximately constant radially and a gradient of outlet flow coefficient which was considered acceptable. A flow coefficient ϕ_t of 0.466 was selected. At design flow, the rotor produced an overall head-rise coefficient of 0.391 as compared to the design value of 0.427. Design efficiency was 92.8 percent while an overall efficiency of 95.5 percent was achieved experimentally. As flow was reduced, the rotor operated in a stalled condition at flow coefficients below $\phi = 0.380$. Static pressure fluctuations increased by a factor of 20 to 30 at the inlet and by a factor of approximately 4 at the outlet when the rotor stalled. At the design flow, a decrease in head-rise coefficient due to cavitation occurred at a net positive suction head H_{sv} of 115 feet (blade cavitation number $\bar{K} = 0.27$). As H_{sv} was decreased from a noncavitating value, for $0.38 < \bar{\phi} < 0.54$, a slight improvement in head rise was indicated just prior to a fall off in performance. Author

N65-34024# Pratt and Whitney Aircraft, Middletown, Conn.
CARBURIZATION OF Cb-1Zr ALLOY
N. S. Bornstein, E. C. Hirakis, and L. A. Friedrich Aug. 1965 24 p refs
(Contract AT(30-1)-2789)
(TIM-927)

Methods for producing carbide coatings on Cb-1Zr alloy were investigated in an effort to improve the anti-galling characteristics of the alloy. Three carburization techniques were developed based on reaction with one of the following materials: (1) a slurry coating of oil-graphite; (2) a methane-argon atmosphere; or (3) a lithium-carbon solution. The coating thickness could be varied within the range of 0.0001 to 0.0006 inch depending upon the choice of technique and process conditions. Encouraging results were obtained in limited performance tests of threaded assemblies and simulated bearings. Based upon the kinetic data obtained as a result of the slurry oil-graphite study, it was tentatively concluded that the mechanism controlling the rate of growth of the carbide layer is the same in all three processes. Analysis of the data provided values for the activation energy for CbC film growth (-72.7 ± 3 kcal/mol) and for Cb_2C film growth (-68.8 ± 3 kcal/mol). Author

N65-34074# ARINC Research Corp., Washington, D. C.
RELIABILITY MANAGEMENT HANDBOOK. VOLUME I: SECTIONS 1 THROUGH 6
14 Feb. 1964 276 p refs Prepared for Aerospace Corp., El Segundo, Calif. Supersedes ATN-64(4303)-1, Vol. I
(Contract AF 04(695)-269)
(TOR-269(4303)-9, Vol. I; ATN-64(4303)-1, Vol. I; AD-463305)

This handbook was compiled to serve as a guide to System Program Office (SPO) reliability coordinators in performing their assigned management tasks and is orientated toward defining these tasks by dividing them into specific functions, categorizing existing Air Force policies and responsibility assignments in respect to the management functions, suggesting procedures for implementing the functions, and serving as an aid in implementing the Air Force reliability program for systems, subsystems, and equipment. The guidance information contained herein is intended to contribute to the positive approach necessary for the achievement of the objectives which govern a reliability program. The functions of reliability program establishment, administration, and surveillance and review are subdivided into detailed management activities. Definitions, pertinent policy and responsibility statements from Air Force directives, suggested implementation procedures and techniques, and listing of additional reference reading are included. Answers to how the SPO reliability coordinator manages a reliability program are presented. R.N.A.

N65-34115# Atomics International Canoga Park, Calif.
SNAP REACTOR MATERIALS DEVELOPMENT, SELF-WELD STUDIES
L. G. Kellogg 1 Jun. 1964 66 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-9643) (Declassified)

The environmental conditions imposed by SNAP systems provide opportunity for contacting surfaces to "weld" together. A test program has been conducted to determine what material combinations have the least adhesion or are least likely to self-weld when they are in contact under load for long periods of time at high temperature and ultrahigh vacuum. Screening tests have been conducted on one hundred and ten combinations while in the high-temperature, ultra-high-vacuum environment. The tests cover the temperature range of 700 to 1300° F with test periods up to 3400 hours in vacuums below 10^{-7} Torr. The screening tests are classified into five basic groups: metal vs metal, metal vs ceramic, metal vs graphite, ceramic vs ceramic, and ceramic vs graphite. A sixth group has been added to include the use of contaminant films with the other groups. Adhesion was noted for some combination in all groups tested. Author

N65-34120# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
HIGH-TEMPERATURE ANTENNA INVESTIGATION AND DEVELOPMENT Interim Engineering Report No. 9, Quarter Ending 30 Jun. 1965
G. F. Buranich [1965] 41 p refs
(Contract AF 33(657)-11100)
(CAL-UB-1807-E-9; AD-466971)

This report contains information on the technology of glass- and ceramic-to-metal seals. The information was obtained from a large number of government research reports and literature of commercial organizations and documents the present state of the art. Experimental results show that the use of a liquid gallium seal in high temperature assemblies requires special attention to possible warping between mating parts. Such warping is readily caused by nonuniform heating and if it creates a 1 mil gap between parts, it can cause the seal to fail. Author

N65-34141# Massachusetts Univ., Amherst. Polymer Research Inst.
A HIGH SPEED STRETCHING APPARATUS FOR OPTICAL STUDIES ON POLYMER FILMS
P. F. Erhardt, R. P. Fillmore, W. C. Yau, D. A. Keedy, and R. S. Stein 5 Apr. 1965 23 p refs
(Contract Nonr-3357(01))
(ONR-TR-81; AD-619678)

This report describes the design, calibration and operation of a pneumo-hydraulic high speed stretching apparatus in which a polymer film sample can be rapidly stretched from both ends. Provision is made for the concurrent measurement of stress and strain. The rise time of the piston velocity is approximately 4 msec and the linear range covers 85–90% of the piston travel. At the maximum operating pressure of 1500 psi, stretching rates in excess of 4000 in/min are obtainable. The apparatus is equipped to take low angle light scattering photographs during rapid extension of the sample and subsequent relaxation. A continuous wave gas laser is used as source and a high speed motion picture camera as the detector. With appropriate polarization of the light beam the system is readily adapted to investigate birefringence changes on stretching, using a photomultiplier as the intensity detector. Instructions for operating the high speed apparatus are appended. Author

N65-34168# IIT Research Inst., Chicago, Ill.
INVESTIGATION OF STRUCTURAL SEALING PARAMETERS AND CONCEPTS FOR SPACECRAFT. PART I: DESIGN CRITERIA Technical Report, 4 Nov. 1964–15 Apr. 1965
Anton Hehn and Frank Iwatsuki Wright-Patterson AFB, Ohio. AF Flight Dyn. Lab., 1965 222 p refs
(Contract AF 33(615)-2202)
(K-6075; AFFDL-TR-65-88, Pt. I; AD-620044)

The many factors that influence the leakage of gases past a seal are discussed and analyzed to apprise the designer of pressurized spacecraft compartments of the problems of achieving and maintaining a seal when extremely low leakage rates are desired. The nature of the leakage path is described, and the ways in which leakage occurs are categorized as interstitial, interfacial, and permeation flow. Methods of predicting leakage for these flow regimes are given with greatest emphasis placed on the interfacial flow phenomenon which is characteristic of lightly loaded, demountable seals. In the experimental phase of this program, the sealing characteristics of elastomers were studied to determine relationships between contact stress and leakage with hardness as a parameter. It is concluded that the analytical techniques presented are applicable to the evaluation or design of spacecraft seals. Author

N65-34171# IIT Research Inst., Chicago, Ill.
INVESTIGATION OF STRUCTURAL SEALING PARAMETERS AND CONCEPTS FOR SPACECRAFT. PART II: LEAK DETECTION—REPAIR, GENERAL ENVIRONMENT, AND MATERIAL PROPERTIES
Anton Hehn and Frank Iwatsuki Wright-Patterson AFB, Ohio. AF Flight Dyn. Lab., 1965 62 p refs
(Contract AF 33(615)-2202)
(AFFDL-TR-65-88, Pt. II; AD-620045)

Factors influencing gas leakage past a seal are discussed and analyzed. The nature of the leakage path is described and the ways in which leakage occurs are categorized as interstitial, interfacial, and permeation flow. Methods of predicting leakage for these flow regimes are given with emphasis on the interfacial flow phenomenon which is characteristic of lightly loaded demountable seals. The sealing characteristics of elastomers were studied to determine relationships between contact stress and leakage with hardness as a parameter. Information related to the overall problem of producing and maintaining a satisfactory seal but not directly applicable to spacecraft seal design or evaluation is presented. The potential detrimental effects of environment on a seal are shown. Problems of leak detection and repair are discussed and techniques investigated by various organizations are directly referenced. General and induced environments to which spacecraft may be subjected are discussed to indicate the severity and almost endless combinations of environments. A discussion of the properties of rubber and plastic materials is included. R.N.A.

N65-34210# Naval Ordnance Test Station, China Lake, Calif.
THE APPLICATION OF ULTRASONICS TO WIRE DRAWING Quarterly Progress Report No. 3, 1 Jan.–31 Mar. 1965
A. T. Robinson, J. C. Connelly, and L. M. Stayton May 1965 11 p refs
(TPR-399; NOTS-TP-3836; AD-618018)

Tin coated copper wire was reduced 38 percent with and without an ultrasonic radiation environment and at draw velocities up to 243 ft/min. Results show a decrease in draw force with increase in energy density to the wire. No effect was observed on draw force with increased draw velocity if energy density remained constant. Author

N65-34221*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio.
VAPOR-DEPOSITED THIN GOLD FILMS AS LUBRICANTS IN VACUUM (10^{-11} mm Hg)
Talivaldis Spalvins and Donald H. Buckley Washington, NASA Oct. 1965 15 p refs
(NASA-TN-D-3040) CFSTI: HC $1.00/MF $0.50 CSCL 13

Thin gold films were vapor-deposited on nickel, nickel-chromium, and nickel rhenium surfaces to be used for lubrication purposes. The durability of the film was determined by friction characteristics. Durability and strong bonding (adhesion) between the film and the substrate are essential when thin films are used as lubricants. Two methods of substrate preparation for vapor deposition were investigated: mechanical polishing and electron bombardment. Friction experiments were conducted with a hemispherical niobium rider sliding on the deposited gold film on a rotating disk. Results of this investigation indicated that the film endurance life during friction experiments was increased when the substrate was electron bombarded and thermally etched prior to vapor deposition on the etched surface at an elevated temperature of 800° F. A diffusion-type interface was believed to be formed between the film and the substrate. Author

N65-34226*# Stanford Research Inst., Menlo Park, Calif.
ELASTIC ORIFICES FOR GAS BEARINGS Technology Utilization Report
Washington, NASA, Aug. 1965 17 p refs Sponsored by NASA (NASA-SP-5029) GPO: $0.20; CFSTI: MF $0.50 CSCL 13I

This report describes an examination of the merits of an elastic orifice in externally pressurized gas bearings. The use of an elastic orifice in a test bearing demonstrated a threefold increase in bearing stiffness over a conventional fixed orifice when the two were compared at a common operating point as defined in this report. This increase should be welcomed wherever externally pressurized bearings are used. In addition, increased bearing stiffness may allow the use of these bearings in some applications formerly restricted to pressurized liquid and rolling contact bearings. Information is included to allow construction of working models of these orifices and duplication of experimental results. Author

N65-34237*# Atomics International, Canoga Park, Calif.
DEVELOPMENT OF A MAGNEFORMING PROCESS FOR THE FABRICATION OF THIN-WALL TUNGSTEN CYLINDERS Final Report
L. Abraham, N. H. Katz, and E. C. Supan 13 Jan. 1965 40 p refs
(Contract NAS3-5211)
(NASA-CR-54316; AI-65-12) CFSTI: HC $2.00/MF $0.50 CSCL 13H

Tungsten powders were consolidated into thin-wall cylinders in a die which compacted the powders at elevated temperature by virtue of the differences in thermal expansion between the die body and mandrel materials. Feasibility of using this consolidation method as a cylinder preforming process was demonstrated, and densities up to 75% of theoretical were obtained. Consolidated cylinders were formed at 1800°C and further densified by magneforming. Magneforming, a high energy rate metal forming technique, was adapted to high temperature, vacuum atmosphere operating conditions. Special tooling and methods were developed to enable metal-forming operations to be carried out at temperatures as high as 1427°C. Presintered thin-wall tungsten cylinder preforms were densified an additional 5 to 10% by this method, but cracked during a subsequent leaching step, which is required to release the cylinders from the magneform workpiece assembly. Equipment, methods, and results are described, and process recommendations are made. Author

N65-34245*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXTRUSION AT TEMPERATURES APPROACHING 5000°F
Charles A. Gyorgak Washington, NASA, Sep. 1965 24 p refs
(NASA-TN-D-3014) CFSTI: HC $1.00/MF $0.50 CSCL 13H

Development of refractory metal alloys having high strength temperatures in excess of 3000°F is reported. Accessories to permit extrusion at ultrahigh temperatures have been developed for a 1020-ton vertical extrusion press. These include a high temperature atmosphere furnace, a rapid billet transfer device, an extrusion straightener, and an eight-tube extrusion retriever. Effects of various lubricants on extrusion quality have been observed but have not been definitely determined. The best quality extrusions have been obtained by the use of a calcium graphite grease for an extrusion temperature range of 1500° to 2300°F. For an extrusion temperature range of 3000° to 5000°F, glass cloth impregnated with tungsten disulphide was best. G.A.L.

N65-34289# Goodrich (B. F.) Co., Akron, Ohio. Aerospace and Defense Products Div.
PRESSURIZED BOW DOME OF A CABLE-REINFORCED RUBBER CONSTRUCTION FOR USE WITH AN/SQS-26 SONAR Monthly Summary Report, Mar. 31–Apr. 30, 1965
W. J. Berus 30 Apr. 1965 12 p
(Contract NObsr-89483)
(Rept.-26; AD-465226)

Fabrication of the aft starboard and port window sections was completed, the parts cured and final finished, and X-ray examinations initiated. Exterior surfaces were found to be smooth with the exception of minor blemishes on the aft port panel. This condition will be smoothed by buffing during the final finish operations. Forward port and starboard panels were installed on the hydrostatic test fixture. Final positioning of these panels is not planned until after installation of the two aft panels. The repaired aft port mold, damaged during initial post cure operations, was examined after panel removal and found to be acceptable for future production. Minor delamination of the surface epoxy coating in the bead area is the only rework required. The second prototype test panel evaluation is continuing. A 5000-cycle 30–50 psi pressure variation was successfully completed and the panel is undergoing a 60-day 40 psi stand test. The hydrostatic text fixture was completed. The instrumentation and test plan were tentatively determined, and required sensors and cabling systems are being finalized for procurement. A request for authorization to ship the acoustic window and other necessary equipment was also submitted. S.C.W.

N65-34345# Battelle Memorial Inst., Columbus, Ohio
LITERATURE SURVEY ON INSPECTION OF WELDS BY RADIO-FREQUENCY WAVES
C. K. Krichbaum, D. E. Stutz, D. Ensminger, and A. F. Leatherman Huntsville, Ala., Army Missile Command, Jun. 1965 24 p refs
(Contract DA-01-021-AMC-11706(Z))
(RSIC-433; AD-470141)

A literature search to determine the possible existence of a radio-frequency electromagnetic inspection method to detect unbonded areas in 1- to 2-inch welded plates has been conducted. Standard methods such as ultrasonics, eddy current, or X-ray were intentionally excluded from the search because they are being investigated by others. Pertinent periodicals and U.S. Government reports and patents for the past 10 to 15 years were searched. Reference texts were studied to aid in establishing practical limits as determined by the fundamental aspects of the problem. The three major results of the search were: (1) No principle or test meeting the defined objectives was found. (2) It can be concluded that due to classical skin-depth and attenuation considerations, an inspection method of the defined type is not feasible. (3) Helicon waves, an electromagnetic wave mode requiring very pure, high-conductivity metals, low temperatures, and high-static magnetic fields, propagate with less attenuation than normal waves. Author

N65-34418# Wien Univ. (Austria). Inst. of Physics.
INVESTIGATION OF THE EFFECTS OF ULTRASONICS ON THE DEFORMATION CHARACTERISTICS OF METALS Final Report, Feb. 1, 1964–Jan. 31, 1965
[1965] 28 p refs
(Contract N62558-3436)
(AD-469264)

By using samples of appropriate length and by producing ultrasonic waves it was proven that there was a marked

maximum of the influence in the stress antinode; however, almost no effects were observed in the displacement antinode. A marked decrease of drawing force was achieved with the metals under investigation by a die fixed in the stress antinode of a bar fixed on the transducer. Investigations on texture and strength of wires drawn through irradiated dies revealed slight differences as compared to the behavior of normally drawn wires. It was shown by experiments with zinc crystals that the amount of prestrain was of importance for the ultrasonic influence on the recovery of deformed samples. In general, ultrasonics accelerates recovery. The influence on the recrystallization behavior was examined using zinc and aluminum of various degrees of purity. Nucleation as well as the growth of the newly formed grains were altered. In order to prove the influence of accumulations of foreign atoms, tests were performed on the formation and disappearance of marked yield points. R.W.H.

N65-34426*# National Aeronautics and Space Administration, Washington, D. C.
SELECTED SHOP TECHNIQUES: 71 SELECTED SUGGESTIONS FOR MACHINISTS, MECHANICS, AND TECHNICIANS Technology Handbook
Aug. 1965 91 p
(NASA-SP-5010) GPO: $0.60; CFSTI: MF $0.75 CSCL 13H

This handboook contains 71 selected suggestions for machinists, mechanics, and those working in related crafts. It shows how problems of a particular type were solved, and describes how fabrication obstacles were overcome by improvising, by creating new tools, or by applying an old and perhaps forgotten technique to a new field. Areas covered include shock absorbers and protective devices, special fabrication techniques, machining, metal forming (sheet metal, tubing, brakes and dies), welding and brazing, lathe attachments, precision tools, special tools and devices, and hoisting. R.R.D.

N65-34469# Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences.
ADHESION OF ELECTRO-DEPOSITED COATINGS USING HIGH SPEED ROTATIONAL TECHNIQUES Final Report
William H. Dancy, Jr. Feb. 1965 47 p refs
(Contract DA-36-034-AMC-0104W)
(SP-3338-114-65U; AD-458270)

Experimental work has been carried out to investigate the adhesion of copper deposited directly on C-1020 and 4140 steel substrates when a rochelle salt plating solution was used for the deposition of the coating. The variations in adhesion resulting from the use of two preplating techniques involving several surface activants were measured. Tumbling as a method of surface preparation has received superficial study. Adhesion values were obtained by observing the rotational speed at which the deposits were separated from the substrate by the body forces that are developed in a high speed rotor. Knowledge of the speed at failure and knowledge of the geometry of the rotating system permit a value of the normal force applied to the coating-substrate interface to be calculated. Author

N65-34516# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AN EXTENSION AND GENERALLY VALID SOLUTION OF KARMAN'S THEORY OF ROLLING
A. Geleji 21 May 1965 29 p refs Transl. into ENGLISH from Acta Tech. Acad. Sci. Hung., v. 46, no. 1, 1964 p 171–196
(FTD-TT-65-219/1+2+3+4; AD-469254)

The assumption that the pressure arc in the roll gap can be replaced by a straight line was used to extend calculations for Karman's solution for specific rolling pressures. In the roll gap, the rolled work piece is not only compressed, but it is also pushed through the gap at a speed which is different from the peripheral velocity of the rolls. This effect was utilized to complete the differential equation of rolling, and to calculate the distribution of the specific rolling pressure along the compressed surface for cold rolling as well as for hot rolling of the work piece. G.G.

N65-34524# Rocketdyne, Canoga Park, Calif.
MULTISTAGED RADIAL IMPELLER PUMP Written Progress Report
15 Sep. 1965 59 p
(Contract AF 04(611)-10547)
(R-6301; AD-470808)

A description of the design and the work accomplished during the first half of the contract period on the multistaged radial impeller, high-pressure liquid hydrogen pump is presented. The design is complete and the pump hardware is approximately 95 percent complete. A complete hydrodynamic redesign of the proposed pump was required from the impulse blade discharge to the volute discharge flange. Additional mechanical redesigns and material changes were also required to maintain thermal contraction compatibility. Author

N65-34555*# Franklin Inst., Philadelphia, Pa. Research Labs.
SUMMARY OF INVESTIGATIONS OF ENTRANCE EFFECTS IN CIRCULAR THRUST BEARINGS
S. P. Carfagno and J. T. Mc Cabe [1965] 154 p refs Supported jointly by Dept. of Defense, AEC, and NASA
(Contract Nonr-2342(00))
(NASA-CR-67177; I-A2049-24; AD-619966) CFSTI: HC $5.00/MF $1.00 CSCL 13I

The pressure depression in the vicinity of the supply hole of an externally pressurized circular thrust bearing having a single, axial supply hole has been studied. Most of the experiments have been conducted with a 2.750 in. diameter bearing with an 0.020 in. diameter supply hole. The supply hole has had both a square edge and a round edge. The test program was based on a dimensional analysis of the gas flow through the bearing. In accordance with this program, pressure profiles were obtained for clearances between 0.2 and 1.6 mil, and supply pressures between 20 and 215 psia. Flow rates were measured and compared with theoretical values. The load was determined by numerical integration under the pressure profile. Most of the data are presented in nondimensional form as indicated by the dimensional analysis. This report includes an account of the entire investigation, with a description of early forms of the apparatus and some of the data obtained therewith. Author

N65-34714 Fairchild Hiller Corp., Bay Shore, N. Y. Strato Div.
APPLICATION OF A POWDER LUBRICATION SYSTEM TO A GAS TURBINE ENGINE Technical Report, Jun.–Dec. 1963
S. Wallerstein Wright-Patterson AFB, Ohio, AF Aero Propulsion Lab., Jun. 1965 29 p refs
(Contract AF 33(657)-8625)
(AFAPL-TR-65-43; AD-619015)

The study indicates a favorable aspect toward the feasibility of incorporating an integral powder lubrication system into a gas-turbine engine. Such a system could use a mixture of 83.3 percent graphite and 16.7 percent cadmium oxide (by weight) with an air carrier in the ratio of approximately 20 parts of air to 1 part powder. Engine bleed air at a rate of 3 percent engine flow rate should be sufficient for carrier gas at all altitudes. Powder would be dispensed and metered through air eductors (venturi tubes). Reclamation of spent lubricant is not considered in this system. Author

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N65-33571 Spectra-Physics, Inc., Mountainview, Calif.
AN INFORMATION NOTE ON AN AIRBORNE LASER TERRAIN PROFILER FOR MICRO-RELIEF STUDIES
Robert C. Rempel and Alan K. Parker (Aero Service Corp., Philadelphia) *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 321–338 Prepared jointly with Aero Service Corp., Philadelphia (See N65-33550 22-13)

A gas laser ranging device which gives very high accuracy differential terrain height information from an airborne platform is presented. This presentation covers the airborne and ground test results of a feasibility model, and the development and probable performance of the final production model. A discussion of the instrument's direct applications to remote sensing and its use in conjunction with existing devices to improve their utility is presented. Author

N65-33686# Space Technology Labs., Inc., Redondo Beach, Calif. Physical Electronics Lab.
RESEARCH ON CHARGE PARTICLE DIAGNOSTICS
Progress Report No. 4, 1–31 Jan. 1964
R. F. Wuerker [1964] 4 p ref
(Contract AF 33(615)-1035)
(STL-4127-6004-SU-000; AD-460936)

Experimental studies of the solid-state laser system which was put into operation and tested as a generator of intense single shot multimegawatt nanosecond radiation pulses, are reported. Satisfactory operation in this mode was verified by directing light onto a whitened surface and observing the scattered radiation with a biplanar photodiode. The gain of the laser rods was measured as a function of input energy to the flash lamp by insertion of neutral density filters into the optical resonant cavity and determined, experimentally, from the threshold for onset of stimulated emission. Tests verified that the crystals were not uniform, but consisted of hot and cold regions. The hot regions had a gain which increased linearly with energy to the flash tube. At an input of 5000 joules, measurements verified a gain of 5 along the hot regions of the crystal. The cold region saturated at gains of 3 to 4. The measured gain and recorded pulse shape were in agreement with theoretical predictions. S.C.W.

N65-33710*# Massachusetts Inst. of Tech., Cambridge.
STIMULATED BRILLOUIN SCATTERING IN LIQUIDS
E. Garmire and C. H. Townes [1964] 11 p refs Submitted for Publication
(Grant NsG-330; Contract AF 19(628)-4011)
(NASA-CR-58214) CFSTI: HC $1.00/MF $0.50 CSCL 20E

Stimulated Brillouin scattering of intense laser light, with a build-up of coherent hypersonic waves, was observed in a number of liquids in an arrangement which allows multiple Brillouin scattering processes and precise measurement of the velocity of hypersonic waves. In solids, a single scattering of the incident light was observed, with a shift to lower frequencies equal to the frequency of the acoustic wave. In liquids, eight orders of successively scattered light waves appear. Each order was generated backward from the incident wave and found its way back to the laser cavity where it was amplified. A giant pulse ruby laser provided the incident light in an experimental arrangement. A glass flat with parallel sides was introduced into the beam as an additional optical resonator in order to separate longitudinal modes and produced a single mode with a frequency spread less than .04 cm^{-1}. Stimulated Brillouin scattering was also observed with the ruby laser under normal operation, but the giant pulse system was used for measurements of frequency shifts due to high spectral purity. R.W.H.

N65-33895# Westinghouse Electric Corp., Baltimore, Md. Aerospace Div.
DEVELOPMENT OF MILLIMETER AND SUBMILLIMETER MASER DEVICES Interim Technical Report No. 7
W. E. Hughes, C. R. Kremenek, and W. E. Richards Wright-Patterson AFB, Ohio, Electron. Technol. Lab., Jul. 1965 38 p refs
(Contract AF 33(657)-10472)
(Rept.-490G; AD-618066)

During this reporting period the major effort has been directed toward improving measuring techniques for a zero field 81-gc maser and a 9.3-gc maser. The improved techniques include new cavity designs, improved superheterodyne receivers, new dewar designs, and more reliable operation. Each improvement is described in detail in the body of this report. Author

N65-33899# Purdue Univ., Lafayette, Ind. Quantum Electronics Lab.
NONLINEAR INTERACTION OF LASER BEAM WITH SOLIDS Final Report, Apr. 1, 1963–Jun. 30, 1965
A. K. Kamal and M. Subramanian 30 Jun. 1965 47 p refs
(Contract Nonr-1100(24); ARPA Order 306-62; Proj. Defender)
(AD-618473)

The first and extensively studied phenomenon is the nonlinear dc polarization that is caused by the second order nonlinear polarization. The quartz crystal is chosen as the dielectric medium. A quantitative relationship between the dc polarization and the intensity of the propagating laser beam is given. A convenient method of detecting dc polarization is presented. With this technique the elements of the second order polarization coefficient can be determined experimentally. Preliminary experimental results on the correlation between the spikings in the dc polarization and in the fundamental frequency of laser oscillation are presented. The second type of nonlinear polarization presented in this report is the initiation of a study on the generation of subharmonics at optical frequencies using high intensity laser sources. Author

N65-33916# Stanford Univ., Calif. Microwave Lab.
UNSTABLE OPTICAL RESONATORS FOR LASER APPLICATIONS
A. E. Siegman Sep. 1964 43 p refs
(Contracts AF 33(615)-1411; DA-36-039-SC-90839)
(ML-1227; AD-460878)

A simple geometrical analysis developed which describes the lowest-order transverse mode in an arbitrary unstable optical resonator of large Fresnel number. The lowest mode is assumed to consist of two oppositely traveling spherical waves which uniformly illuminate the two end mirrors. The centers of curvature of these two waves (which are not in general the mirror centers of curvature) are found by requiring that each center be the image of the other upon reflection from the appropriate spherical end mirror. The resonator losses, found from simple geometrical considerations, are given by simple analytical expressions and are entirely independent of the mirror sizes. The equi-loss contours on the usual mode chart are hyperbolae. The present results agree well with more exact results calculated by Fox and Li for the unstable case, and with experimental results on a ruby laser having a divergent

spherical surface ground directly onto the ruby rod. Unstable resonators of this type appear potentially useful for transverse mode control and for diffraction output coupling. Author

N65-33995# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
INVESTIGATIONS OF A SODIUM–MERCURY METAL VAPOR LASER
Clinton Tucker Meneely (M.S. Thesis) Mar. 1965 60 p refs (SP/PH-65-15; AD-617950)

While many gaseous lasers have been developed using noble gases, relatively few gaseous lasers have been developed which operated on metallic vapors, perhaps because of the technical difficulties involved. Much of the basic research into metallic energy level systems and their interactions with other systems has been done long ago by the early spectroscopists. Their findings need only to be reappraised in the light of laser theory to be useful. It is shown that the "technical difficulties" involved in metallic vapor systems can probably be overcome with careful equipment design. TAB

N65-33997# Autonetics, Downey, Calif.
OCCUPATIONAL LASER HAZARDS—A SURVEY OF THE LITERATURE
Marnelle Kinney 7 Jul. 1965 21 p refs
(TS-1245/3111; AD-617913)

The need for guidelines to protect personnel involved in laser research is generally recognized. The literature reveals, however, that views differ as to what precautions should be required. This bibliography contains 48 entries arranged alphabetically by author, and includes papers published in the open literature and reports which may be obtained through the Defense Documentation Center. The period of time covered is from 1956 through May 1965. Author

N65-34050# Sylvania Electric Products, Inc., Mountain View, Calif. Electronic Defense Labs.
LIGHT MODULATION DETECTOR Interim Engineering Report No. 3, 15 Oct. 1964–15 Jan. 1965
Russell Targ, W. D. Bush, G. A. Massey, and S. E. Harris 16 Jan. 1965 28p refs
(Contract AF 33(615)-1938)
(EDL-M811; AD-610057)

Determination of the feasibility of an automatic frequency-controlled (AFC) optical heterodyne receiver for detection and demodulation of microwave-modulated light is considered. Assembly and testing was completed of an AFC system to track frequency variations between a laser local oscillator and an independent laser transmitter sending microwave information. A supermode laser is demonstrated which uses an output beam from a multimode laser without the power loss inherent in conventional approaches involving the suppression of modes. A frequency lock, achieved through the use of automatic acquisition circuits, does away with manual tuning of lasers. The increased coherence provided by the FM laser is used to concentrate the power from a multimode laser in a narrow frequency range. Output of the FM laser is demodulated of its FM to leave only the carrier which contains the power formerly in the FM sidebands. M.W.R.

N65-34081 Library of Congress, Washington, D. C. Aerospace Technology Div.
GIANT PULSES FROM A NEODYMIUM LASER WITH A PHOTOSENSITIVE LIQUID Q-SWITCH
John G. Kourilo *In its* Foreign Sci. Bull., V. 1, No. 9 Sep. 1965 p 64–66 refs (See N65-34075 22-34)

Two Soviet experimental studies are compared with a similar U. S. study on producing giant pulses from a neodymium-doped glass laser with the aid of reversibly bleachable polymethine dye solutions. Similarities in the experimental setup and some characteristics of the laser emission were noted in both the Soviet and the U. S. studies. The stated purpose of the Soviet studies was to achieve a pulse effect in a neodymium laser similar to that previously produced in a ruby laser with reversibly bleachable phthalocyanine or kryptocyanine solutions. The most significant Soviet achievement was a single, symmetric pulse of 35-nsec width and 5-Mw peak power produced with the same polymethine dye as in the U. S. study. The energy output of this pulse was 7% of the total ordinary laser output. Author

N65-34097 Naval Ordnance Lab., Corona, Calif. Electricity and Magnetism Div.
LASER PROGRAM. ARGON BOMB INTENSITY
R. L. Conger, J. H. Johnson, L. T. Long, and J. A. Parks *In its* Foundational Res. Proj. 1 Jun. 1965 p 21–25 (See N65-34093 22-34)

A series of light energy measurements were made with argon bombs constructed from 1 qt and 1/2 gal cylindrical ice cream cartons. First 100 grams of composition C-3 explosive was pressed into the base of two cartons of equal size, which were then placed together with the open ends facing each other. Argon gas was allowed to flow through the bomb long enough to displace five times the volume of the cartons. A glass rod was placed at the junction of the two bombs to serve as a light measuring probe. This glass rod was at one end of a 2 in steel pipe 4 ft long, and at the other end was a 1P39 vacuum phototube. The pipe placed the phototube far enough away from the bomb so that it would not be destroyed by the blast until after the glass rod had been destroyed. Various configurations of the bombs were tested to determine scaling factors. These tests demonstrated the significance of the solid angle subtended by the shock wave as seen by the light probe. Results showed that light energy received by the glass rod is proportional to the square root of the explosive charge. C.T.C.

N65-34108# Northeastern Univ., Boston, Mass.
RESEARCH ON STORAGE DIODE LASERS Final Technical Summary Report, 1 Apr. 1963–15 May 1964
Richard G. Seed and Karl M. Hergenrother [1964] 50 p refs
(Contract Nonr-4106(02); ARPA Order 306-62; Proj. Defender)
(AD-618297)

Research on a proposed storage diode laser is described in detail. The desirability of such a device in many potential applications is discussed. The design theory is presented in detail. Representative estimated numbers are presented. Four possible storage diode laser configurations are described, of which the most promising involves a low current storage pulse and high current trigger pulse in a long lifetime material. The possibility of obtaining long lifetime by the shift from direct to indirect transition is discussed. Negative experimental results with extreme high current pulses in germanium and silicon are presented. Additional experiments required for proof are described. Related experimental results on the observation of reverse emission of gallium arsenide, and on the shift of the absorption edge in germanium are presented. The design of diode laser pulsers is reviewed in general. Three specific circuit configurations are presented. An electrical double pulse is described. And finally the technology of image converters and coolers used is described. Author

N65-34155# Florence Univ. (Italy). Istituto di Onde Elettromagnetiche.
RESEARCH ON OPEN RESONATORS. PART I: THEORY OF FLAT-ROOF RESONATORS. PART II: EXPERIMENTAL TESTS OF MICROWAVE MODELS OF OPTICAL RESONATORS Interim Scientific Report No. 1
G. Toraldo di Francia, P. F. Checcacci, and A. M. Scheggi May 1965 35 p refs
(Contract AF 61(052)-871)
(AFCRL-65-568; AD-619879) CFSTI: HC $2.00/MF $0.50

A microwave or laser resonator with flat-roof mirrors is theoretically discussed. When the angle of the roof is extremely small, on the order of 10^{-3} radians for microwaves or 10^{-3}–10^{-6} radians for optics, this resonator has some features in common with the confocal resonator. A scaling method is applied to the study of the characteristics of a laser resonator. Experimental tests performed on a F.-P. resonator with plane square mirrors operating in the X-band are described. Measurements of frequency and quality factors of the resonator modes along with field distributions are reported and the results discussed. Particularly the close correlation between mirror deformations and field patterns is shown. Author

N65-34184# Korad Corp., Santa Monica, Calif.
GaAs LASER DIODES Quarterly Progress Report, 1 Jan.–31 Mar. 1965
R. A. Sehr Fort Monmouth, N. J., Army Electron. Command [1965] 24 p refs
(Contract DA-28-043-AMC-00235(E))
(QPR-3; AD-619532)

Three different methods of junction formation were employed to obtain GaAs laser diodes for room temperature operation and include diffusion of An into an n-type substrate under arsenic pressures of about 10 atmospheres, deposition of an n-type layer onto a p-type substrate from a liquid Ga melt, and vapor epitaxial growth of an n-type layer onto a p-type substrate. The initial results of these measurements indicate that the high pressure diffused junctions yield room temperature laser diodes of comparable performance to those in which the junction is grown by liquid solution epitaxy. Laser diodes in which the p-n junction was formed by vapor phase epitaxy did not lase at room temperature. Author

N65-34674# Kollsman Instrument Corp., Elmhurst, N. Y.
SIMULATOR, WEAPON, FIRING AND RANGING (LASER) SYSTEM
Port Washington, N. Y., Naval Training Device Center, Mar. 1965 92 p refs
(Contract N61339-1311)
(NAVTRADEVCEN-1311-1; AD-619164)

This report describes Kollsman's Laser Weapon Simulator system—a device developed around a laser that simulates the important effects of a tankgun fired at a target, and accordingly enhances the training of tank gunners. The theory of operation of the laser (plus optics), and the associated power supply, is presented in detail. Procedures for installing the simulator system on the tank and the target in the downrange area, for performing pre-operation checkout, adjustment, and alignment, for conducting training exercises, and for troubleshooting and repairing the equipment, are also provided in detail. Safety precautions necessary in aligning, operating, and repairing the equipment are carefully noted. Described are the test procedures used and the results obtained in an experiment to determine the energy reflected from a retroreflector (Scotchlite) located two hundred feet away from the Laser Weapon Fire Simulator as measured by a detector located adjacent to the laser source. The detector, a photomultiplier, established that 0.18×10^{-8} joules would fall on the unaided eye of the trainee and this energy level is shown to be safe. Author

N65-34706# Air Force Systems Command, Kirtland, AFB, N. Mex. Air Force Weapons Lab.
PULSE LASER INSTRUMENTATION Technical Report, Apr. 1962–Dec. 1963
Charles W. Bruce and Earl H. Collet Jun. 1965 67 p refs
(ARPA Order 313)
(WL-TR-64-127; AD-618031)

The development of the techniques and devices used to measure pulse laser output is described. Included are discussions of principles, physical design, associated circuitry, and impedance-matching techniques. The instrumentation system consists of a total beam calorimeter suited to the laser energy range and an integrator whose signal is correlated to the calorimeter measurement. The calorimeter is either an absorbing surface or volume arranged so that the energy is well trapped. The surface absorber is a thermally isolated hollow silver sphere whose inner surface has been highly polished and whose heat capacity can be accurately calculated. The laser beam is admitted into the sphere at the focal point of a short-focal-length lens through a very small hole off center of the sphere. The volume absorber is cone-shaped as a result of various requirements and considerations. Thermistors or thermocouples are used to measure the resultant temperature rise. The use of these devices has several merits, chiefly high accuracy, stability, and relative simplicity. In addition, the devices lend themselves to the measurement of a wide range of energy densities. Author

N65-34713# Minnesota Univ., Minneapolis. Dept. of Electrical Engineering.
A THEORETICAL EXAMINATION OF OFF-AXIAL DIRECTIONALITY IN LIGHT FROM OPTICAL MASERS
Chandra M. Varma and R. J. Collins (M.S. Thesis) [1964] 63 p refs
(Contract Nonr-710(61))
(TR-2; AD-618632)

An explanation is suggested for the appearance of highly directional off-axial radiation from solid state optical masers of circular cross section which takes the form of rings in the far field. The rings are due to the propagation of high order TE and TM mode in the cavity. This is established by calculating the far field pattern when the distribution characteristic of such modes exists at the aperature of optical masers. The ring angle was related to the mode order. The rings appearance at discrete angles was explained by proving that the frequency degeneracy in a multimode cavity is dependent on the angle that wave vectors make with the axis. There are certain discrete angles at which the degeneracy is high and modes corresponding to such angles will be preferentially selected. It is shown that the amount of degeneracy at any particular angle depends on the type of nonuniformity in the reflectivity of the mirrors. Nonuniformities in the gain distribution inside the cavity lead to mode mixing with the creation of new modes with reduced thresholds of oscillation. The effect is larger for medium nonuniformities than for mirror nonuniformities by a factor proportional to the cavity length. R.N.A.

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N65-33610* Air Force Systems Command, Wright-Patterson AFB, Ohio.
BACKGROUND OF PILOTED SIMULATOR DEVELOPMENT
C. B. Westbrook *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. B [1964] 69 p refs (See N65-33604 22-30) CFSTI: HC $6.00/MF $1.50

In this paper a review is made of the piloted simulation facilities. An attempt is made to classify these facilities and to understand how and why these facilities are needed and came into being and how they are used. Some thoughts on the philosophy of use of simulation are offered and conclusions presented. Author

N65-33652# Joint Publications Research Service, Washington, D. C.
CORROSION OF URANIUM AND ITS ALLOYS
V. V. Gerasimov 26 Aug. 1965 53 p refs Transl. into ENGLISH of 2 Chapters from the book, "Korroziya Urana i Yego Splavov" Moscow, Atomic Publishing House, 1965 p 40–95
(JPRS-31728; TT-65-3223) CFSTI: $3.00

CONTENTS:

1. CORROSION OF URANIUM ALLOYS IN AQUEOUS MEDIA V. V. Gerasimov p 1–24 refs (See N65-33653 22-17)
2. CORROSION OF URANIUM AND ITS ALLOYS IN NON-AQUEOUS MEDIA AND PROTECTIVE COATINGS V. V. Gerasimov p 25–48 refs (See N65-33654 22-17)

N65-33653 Joint Publications Research Service, Washington, D. C.
CORROSION OF URANIUM ALLOYS IN AQUEOUS MEDIA
V. V. Gerasimov *In its* Corrosion of Uranium and Its Alloys 26 Aug. 1965 p 1–24 refs (See N65-33652 22-17) CFSTI: $3.00

Various methods of increasing the corrosion resistance of uranium in water and steam are discussed, with particular emphasis on alloying and heat treatment. It was pointed out that the highest resistance was exhibited by alloys of uranium with hafnium, nickel, niobium, titanium, zirconium, molybdenum, and silicon. Effects of different combinations of these alloys on the corrosion resistance are described, in relation to heat treatment and exposure to aqueous media. Tabular data on uranium alloys are included for corrosion rates in boiling distilled water; corrosion resistance in water, and in water and steam. Corrosion rates after various heat treatments are also tabulated. M.G.J.

N65-33654 Joint Publications Research Service, Washington, D. C.
CORROSION OF URANIUM AND ITS ALLOYS IN NON-AQUEOUS MEDIA AND PROTECTIVE COATINGS
V. V. Gerasimov *In its* Corrosion of Uranium and its Alloys 26 Aug. 1965 p 25–48 refs (See N65-33652 22-17) CFSTI: $3.00

Mechanisms of atmospheric corrosion of pure uranium and uranium alloys are described in relation to the effects of temperature and humidity on the corrosion rates. The influence of the electric field on the oxidation rate of metals, and uranium oxidation according to the linear law are also discussed. Various alloy combinations are considered, and data are given for their resistance under different test conditions. Methods of coating uranium are also described, and test results on the corrosion resistance properties of nickel and silver are tabulated according to method of production, media, temperature, and length of test. The effect of temperature on the oxidation rate of uranium in the steam phase, and the conflagration curve of uranium tempered in oxygen from the β-region are plotted. Tables list the corrosion rates of uranium in water steam, in argon, and in saturated steam; and the free energy of formation of uranium compounds. M.G.J.

N65-33682# Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center.
EVALUATION OF SPECIAL METAL PROPERTIES—REVIEW OF RECENT DEVELOPMENTS
J. E. Campbell 18 Sep. 1964 4 p refs
(AD-460862)

A general review of research relating to the evaluation of special properties of metals deals with tensile, shear, fatigue and other properties at low temperatures; fracture testing of high strength materials; effect of section size on tensile strength and other mechanical properties, shear properties of aluminum alloys; drop-weight tests; and the Space Materials Handbook. M.W.R.

N65-33684# United Aircraft Corp., East Hartford, Conn. Research Labs.
EXPLORATORY INVESTIGATION OF GLASS-METAL COMPOSITE FIBERS Bimonthly Progress Report No. 5, Dec. 14, 1964–Feb. 13, 1965
John E. Cox and Richard D. Veltri 9 Mar. 1965 23 p
(Contract Now-64-0389-f)
(D910242-5; AD-463903)

Development work on the production of continuous filaments of metal-glass composites continued. Protection tube studies for introducing molten beryllium into the forming zone of glass fibers were made with water-cooled stainless steel, aluminum oxide, and boron nitride. Short lengths of beryllium-in-glass fibers were obtained, but the destructive reaction between beryllium and glass prevented a continous process. The use of anodized beryllium did not noticeably improve the process. Copper-glass composite studies included investigations of specimen preparation techniques, various commercial glass compositions, and furnace design changes. Some submicron diameter copper filaments were obtained. Initial experiments with pressure ejection of molten glass through a boron nitride orifice and fiber starting by attachment to the winding drum were successful. G.G.

N65-33687# Battelle Memorial Inst., Columbus, Ohio.
FURTHER INVESTIGATION OF NOTCH SENSITIVITY OF REFRACTORY METALS Bimonthly Progress Report, Aug. 1–Sep. 30, 1964
C. W. Marschall, F. C. Holden, A. Gilbert, and B. A. Wilcox 9 Oct. 1964 14 p refs
(Contract AF 33(657)-10363)
(BMPR-3; AD-460900)

Fracture-toughness studies are being made on coated TZM-Mo alloy and D43-Cb alloy in order to evaluate the effect of protective coatings on this material parameter. Modifications to the crack-stop testing procedure are described, and the results obtained using this technique are presented. In addition, the tensile properties of the sheet material from −196 to 500 C are included, and further preparations toward the application of the Moiré technique for measuring strain at notch roots are described. Author

N65-33731# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INTERNATIONAL POWDER METALLURGICAL CONFERENCE IN SMOLENICE

Kohlermann 25 May 1965 13 p refs Transl. into ENGLISH from Neue Hütte (Berlin), no. 3, 1963 p 187–190
(FTD-TT-65-139/1; AD-467250)

Twenty-three articles which deal with powder metallurgy are briefly described. Topics covered include: sintered high melting point compounds, the kinetics of sintering in the presence of the liquid phase, the mechanical properties of materials produced by powder metallurgy, friction materials, metal alloys as high temperature materials, the mechanical properties of hard-metal alloys, and metal-oxide sintering. G.A.L.

N65-33759# Rock Island Arsenal Lab., Ill. Research and Engineering Div.

A STUDY OF INNOVATIONS OF SALT SPRAY (FOG) TESTING EQUIPMENT

Jacob Knanishu May 1965 23 p refs
(RIA-65-1191; AD-619385)

Tests were conducted to compare the "regular type" salt spray cabinet using the conventional salt solution aspiration mechanism with the new Fog Dispersion Tower Conversion Kit means of salt-fog emission. Tests indicated that better fog distribution and less consumption of solution result from the use of the conversion tower type equipment. Collection rate data obtained by placing collection funnels at certain positions, or stations, proved this to be true. The ASTM designated (B117-54T) equipment sometimes fails to complete a full weekend of operation (64 hours), while the Conversion Tower-Type apparatus operates for 96 hours or more before the solution supply is exhausted. It was found that practically no reduction of the quantity or quality of the "fog" (in the collection graduates) resulted as the solution level in the supply tank decreased. Author

N65-33774# Radio Corp. of America, Lancaster, Pa. Electronic Components and Devices.

CESIUM COMPATIBILITY OF THERMIONIC CONVERTER STRUCTURAL MATERIALS

W. B. Hall and S. W. Kessler [1965] 10 p
(Contract NObs-84823)
(AD-463878)

Various metals were tested for exposure to cesium in a vessel constructed from stainless steel pipe. The test vessel, cesium capsule, and metallic samples were prepared for testing by degreasing, ultrasonic cleaning with a detergent, four rinsings, and drying at 100° C. Samples were loaded in the test vessel by suspension from a tree of nickel wire to avoid an attack on a metal that might be compatible. The vessel was baked and exhausted at 800° C for a minimum of two hr and removed when the pressure in the vacuum system dropped to less than 10^{-8} torr. The vessel was cesiated and the cesium capsule was removed. It was found that some ceramic bodies, metals, and alloys were compatible with cesium vapor, and testing results are tabulated. Slight traces of unknown impurities on the ceramic surface promoted attack by cesium vapor; and it was concluded that if reactive metals are to be used in the converter, exhausting methods must be improved to exclude impurities. Metal processing and procurement must also be improved to exclude microstructure phases that are prone to cesium attack. M.W.R.

N65-33775# Atomic Energy Commission, Washington, D. C. Div. of Technical Information

EFFECT OF OXYGEN CONCENTRATION ON THE ELECTRIC AND THERMOELECTRIC PROPERTIES OF COMPOUNDS OF THE TERNARY $Bi_2Te_{3-x}Se_x$

K. Smirous and L. Stourac [1959] 7 p refs Transl. into ENGLISH from Czech. J. Phys. (Prague), v. 10, 1960 p 659–662
(AEC-TR-6585)

The effect of oxygen on the electric and thermoelectric properties of semiconducting compounds of the $Bi_2Te_{3-x}Se_x$ system was investigated. Addition of oxides was found to decrease electric conductivity but had no effect on thermo-emf; and this was attributed to decrease in electron mobility even though the concentration of electrons remains unaffected by the presence of oxygen. It is concluded that the oxygen affects the efficiency of transformation of thermal into electric energy as well as the reverse conversion. Study of a $Bi_2Te_2 \cdot 4SeO_6$ system indicates the effect is due to Bi_2O_3 lower bismuth oxides dissolved in the initial metallic bismuth. The oxygen, which has an undesirable effect on the electric properties of the system, can be eliminated by treating the initial components at high temperature in a reducing atmosphere. M.W.R.

N65-33778# Case Inst. of Tech., Cleveland, Ohio.

ELECTRICAL RESISTIVITY OF THIN NICKEL FILMS DEPOSITED IN ULTRA-HIGH VACUUM

Richard G. Meyers Jun. 1964 25 p refs
(Contract AT(11-1)-623)
(COO-623-101)

The resistivity and temperature derivative of resistivity were determined for thin nickel films deposited and measured in ultra-high vacuum. For annealed films the thickness variation of the resistivity can be accounted for by the Fuchs-Sondheimer theory with completely diffuse surface scattering. The deduced values of bulk resistivity $P\infty$ and bulk mean free path λ at 20° C are $P = 7.6\ (10^{-6})$ ohm-cm and $\lambda = 300$ Angstrom. The temperature derivative of resistivity is found to be reduced about 6% from the known bulk value for nickel, except for the thinnest films (< 100 A) which have higher than bulk values. The reduction is interpreted in terms of differential thermal expansion between film and substrate. Author

N65-33784# Nuclear Metals, Inc., Concord, Mass.

FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. DEVELOPMENT OF URANIUM-BASE ALLOYS STRENGTHENED BY SLIS TECHNIQUES Summary Technical Report, 1 Jul. 1963–30 Jun. 1964

A. R. Kaufmann and W. C. Muller 2 Dec. 1964 46 p ref
(Contract AT(30-1)-2784)
(NMI-1262) CFSTI: $3.00

Improved alloys of uranium were developed by SLIS techniques which achieve dispersions with metallic particles rather than oxides. Alloys were prepared, using elements highly insoluble in the solid state and having little tendency to agglomerate at elevated temperatures, by dissolving the elements in liquid uranium and rapid quenching. Alloys developed are U–Be, U–Be–C, U–C, and U–Al–Si. At 600° C, splatcooled alloys, except for U–C, exhibit hardness values as high as three times that of unalloyed uranium. When U–C was aged at 100 hr at 600° C, hardness improved by a factor of two and there was an increase of 1.7×10^{12} particles per cc. Similar aging produces a moderate decrease in hardness of U–Be–C and U–Al–Si and a constant hardness in extruded U–Be. Except

for splatcooled U–Al–Si, there appears to be a relationship between particle density and hardness values at elevated temperatures. Ultimate tensile strengths of the splatcooled alloys were substantially higher than that for unalloyed uranium.
M.W.R.

N65-33795# MSA Research Corp., Callery, Pa.
MULTICOMPONENT ALKALI METAL ALLOYS Second Quarterly Progress Report, 1 Oct. 1964–1 Jan. 1965
F. Tepper and J. King 13 Jan. 1965 18 p ref
(Contract AF 33(615)-2061)
(MSAR-65-04; AD-463724)

A program is being continued to evaluate multicomponent alkali metal alloys as low melting fluids with wide liquid ranges. Definition of portions of liquidus surfaces of ternary alkali metal systems has been initiated. From the data generated to date, only NaKCs appears to form ternary minimums less than −40° C. An equation is given for the vapor pressure of eutectic NaKCs between 716 and 1064° C (1319.5 and 1947° F). The density of NaKCs eutectic has been measured to 530.7° C. Initial compressibility data for NaKCs is described.
Author

N65-33807*# National Aeronautics and Space Administration, Washington, D. C.
PREPARATION OF Ti, Zr, Nb, AND Ta SOLID SOLUTIONS WITH Hf CARBIDE, AND A STUDY OF THEIR PHYSICAL PROPERTIES [POLUCHENIYE I ISSLEDOVANIYE FIZICHESKIKH SVOYSTV TVERDYKH RASTVOROV KARBIDOV Ti, Zr, Nb, Ta S KARBIDOM Hf]
G. V. Samsonov and V. N. Paderno Sep. 1965 19 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Metally (USSR), no. 1, 1965 p 180–188
(NASA-TT-F-9565) CFSTI: HC $1.00/MF $0.50 CSCL 11F

Description of the procedure for preparation and of the physical properties of HfC-TiC, HfC-ZrC, HfC-NbC, and HfC-TaC solid solutions. Although these are less known than other carbide solid solutions, they are promising as ingredients for hgih-temperature alloys because of their high melting points. Preparation consists in the reduction of corresponding metallic oxides with carbon in an atmosphere of hydrogen or in vacuo, with or without simultaneous hot compression of reduction products. Physical properties of the carbides and those of the 18 prepared carbide compounds are tabulated. Curves of microhardness, specific thermal conductivity, thermal emf, heat conductivity, and Hall's constant vs variations in Hf carbide alloy composition are given.
Author

N65-33808*# National Aeronautics and Space Administration, Washington, D. C.
INVESTIGATION OF THE PHASE EQUILIBRIUM IN THE Ti-Al_2O_3 SYSTEM [ISSLEDOVANIYE FAZOVOGO RAVNOVESIYA V SISTEME Ti-Al_2O_3]
I. I. Kornilov and V. V. Glazova Sep. 1965 12 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Metally (USSR), no. 1, 1965 p 189–194
(NASA-TT-F-9566) CFSTI: HC $1.00/MF $0.50 CSCL 11F

Investigation of the melting point, microstructure, microhardness, and electrical resistance of a series of Ti-Al-O alloys with 0 to 30 wt.% Al_2O_3, as a part of the study of the phase equilibrium in ths system. Experiments and measurement techniques are described. The nature of the phase equilibrium in these alloys with up to 30 wt% Al_2O_3 is treated. A diagram of the state of the Ti-Al_2O_3 illustrating the results and photographs of alloy microstructur s ar includ d.
Author

N65-33811*# National Aeronautics and Space Administration, Washington, D. C.
RECENT ADVANCES IN CERAMIC MATERIALS APPLICABLE IN SPACE TECHNOLOGY [RECENTS PROGRES DANS LES MATERIAUX CERAMIQUES UTILISABLES EN TECHNOLOGIE SPATIALE]
J. Schmitt Sep. 1965 36 p refs Transl. into ENGLISH from FRENCH Presented at the 7th Intern. Aeron. Congr., AFITAE, Paris, 14–16 Jun. 1965
(NASA-TT-F-9575) CFSTI: HC $2.00/MF $0.50 CSCL 11B

Various composite materials for use in space technology are reviewed, including sandwich constructions, composite ceramic foams, formed and unformed ceramic glazings, with and without thermoplastic and thermosetting resin binders, with and without lightening agents, whisker reinforcements, etc. Work done at Thomson-Houston on increasing the effective protection period of ceramics for re-entry cones, leading edges of ailerons, linings for duct throats, etc. showed that the addition of organic or mineral pellets, silica fibers, and endothermal materials resulted in an extension of the effective protection period to 350 sec at a surface heat of 2500° C and a cold zone of about 200° C. Further increase in this period is expected by combination of various heat barriers and addition of endothermal materials superior to NH_4Cl

N65-33827*# Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. Materials Research and Development Dept.
GENERATION OF LONG TIME CREEP DATA ON REFRACTORY ALLOYS AT ELEVATED TEMPERATURES Eighth Quarterly Report
J. C. Sawyer and E. A. Steigerwald 7 Jul. 1965 49 p ref (Contract NAS3-2545)
(NASA-CR-54457) CFSTI: HC $2.00/MF $0.50 CSCL 11F

Creep data obtained under ultrahigh vacuum conditions are presented for molybdenum-base alloys TZC and TZM, columbium-base alloy Cb132M, and arc-melted tungsten, arc-melted tungsten-25% rhenium, and Sylvania A. The results indicate that in the 1800° F (982° C) to 2200° F (1204° C) temperature range the TZC alloy possesses the greatest degree of creep resistance.
Author

N65-33838*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HYPERVELOCITY IMPACT DAMAGE CHARACTERISTICS IN BERYLLIUM AND GRAPHITE PLATES AND TUBES
James H. Diedrich, Irvin J. Loeffler, and A. R. Mc Millan (Gen. Motors Corp.) Washington, NASA, Sep. 1965 30 p refs (NASA-TN-D-3018) CFSTI: HC $2.00/MF $0.50 CSCL 11F

Experiments were conducted on beryllium and graphite to determine their behavior under hypervelocity impact. Both materials were impacted with 1/8- and 3/32-inch-diameter spherical projectiles of pyrex and aluminum accelerated to a nominal velocity of 25 000 feet per second by an accelerated reservoir light gas gun. The targets were in the form of flat plates and tubes and were generally tested at temperatures of 70°, 700°, or 1300° F. Beryllium metal was tested as hot-pressed disks and as tubes fabricated from sintered-powder, cast, and extruded material. All beryllium tubular targets had high-strength inner liners. The various graphite compositions that were tested included flat blocks of ATJ, ZTA, and pyrolytic graphite. A tubular target of AGSR graphite was also tested. Each material exhibited characteristic brittle crater damage and supplamentary cracking damage. The cracking damage was influenced by target size and shape and for beryllium by the processing method of the armor material. The projectile penetration depths were correlated with a frequently used empirical penetration criterion based on target modulus of elasticity.
Author

N65-33850# Stanford Univ., Calif. Dept. of Materials Science.
THE INFLUENCE OF STRAIN AND GRAIN SIZE ON THE CREEP SUBSTRUCTURE OF Fe-3.0% Si Ninth Technical Report
Craig R. Barrett, William D. Nix, and Oleg D. Sherby 1 Jun. 1965 20 p refs
(Contract Nonr-225(60))
(DMS-65-25; AD-618202)

Three different grain sizes were investigated, namely 0.05, 0.1 and 0.3 mm. The type of subgrain structure generated during creep is somewhat dependent on the grain size. The 0.05 mm grain size samples exhibit an equiaxed subgrain structure, whereas the 0.1 and 0.3 mm grain size samples exhibit both equiaxed and banded subgrain structures. The banded dislocation substructure is believed due to slip band formation. Measurements of the dislocation density, ρ, not associated with subboundaries, reveal the following general trends. During primary creep, ρ is a function of strain, decreasing with increasing strain. During steady state creep, ρ is independent of both strain and grain size. Assuming that the density of dislocations not associated with subboundaries is an accurate measure of the mobile dislocation density, the average dislocation velocity, v, is also a function of strain during primary creep, generally decreasing as the strain increases. Author

N65-33871*# Southern Research Inst., Birmingham, Ala.
EFFECT OF PROTECTIVE COATINGS ON THE STRESS-CORROSION PROPERTIES OF SUPERSONIC-TRANSPORT SKIN MATERIALS Eleventh Quarterly Status Report, 1 Jun.–31 Aug. 1965
J. O. Honeycutt and A. C. Willhelm 24 Sep. 1965 34 p refs
(Contract NASr-117)
(NASA-CR-67014) CFSTI: HC $2.00/MF $0.50 CSCL 11F

Investigation of selected coatings to protect metal substrates of supersonic transport skin materials from stress corrosion continued. Results from the 3000 hr exposures to hot salt at 550° F, and humid salt at 95° F showed that the AM 350 SCT stainless steel substrate will require protection from stress corrosion in salt-laden humid environments, and duplex annealed Ti–8Al–1Mo–1V alloy will require protection from stress corrosion when exposed to dry salt at 550° F. Aluminum-modified silicone provides excellent protection for at least 3000 hr in either hot salt environments at 550° F, or in humid salt environments at 95° F. However, catalytically cured silicone provides protection only at 95° F, and quickly shredded from each substrate in the hot salt environment at 550° F. W.M.R.

N65-33872*# Lockheed Missiles and Space Co., Palo Alto, Calif
ELECTROLYTIC PREPARATION OF HIGH DIELECTRIC FILMS Quarterly Report, May 4–Aug. 3, 1965
A. E. Hultquist and M. E. Sibert [1965] 12 p
(Contract NASw-969)
(NASA-CR-67013) CFSTI: HC $1.00/MF $0.50 CSCL 11F

Investigations continued on the preparation of high dielectric materials in thin film form on refractory metal substrates by electrochemical techniques. Emphasis was placed on improving the capacitance of titanate, zirconate, niobate, and tantalate films by vacuum heat treatment. The baths used were of the EDTA type and Group IIA and IA cations were used as complexed potential film modifiers. Vacuum heat treatment of coatings formed in EDTA baths on titanium and niobium produces a low resistance film (poor results were obtained for tantalum and zirconium). When reoxidized in air at 200° to 300° C the coating becomes a dielectric with enhanced capacitance and lower losses. Using the values of coatings on titanium treated in such a manner, and thickness measurements made by the Dermitron instrument, the apparent dielectric constants were calculated and are tabulated. The values show that a high dielectric thin film can be produced by the vacuum heating and reoxidation healing steps and that this technique produces an order of magnitude improvement for titanium and niobium based films. R.N.A.

N65-33876*# Battelle Memorial Inst., Columbus, Ohio.
NONDESTRUCTIVE MEASUREMENT OF RESIDUAL STRESSES IN METALS AND METAL STRUCTURES
Koichi Masubuchi Huntsville, Ala., Army Missile Command, Apr. 1965 141 p
(Contract DA-01-021-AMC-11706(Z))
(NASA-CR-64918; RSIC-410) CFSTI: HC $4.00/MF $1.00 CSCL 11F

This report presents a state-of-the-art survey of the nondestructive measurement and evaluation of residual stresses produced in metals and metal structures. The report is concerned primarily with residual stresses produced during the fabrication of structures made of high-strength aluminum alloys. Discussions are presented in four sections which provide the following: (1) fundamental information on residual stresses that is needed to understand measurement techniques; (2) review of methods of measuring residual stresses, including stress-relaxation techniques, X-ray diffraction technique, the ultrasonic technique, the hardness technique, and cracking techniques; (3) measurement of residual stresses during fabrication of metal structures (methods of measuring residual stresses and typical experimental data are described); and (4) selection and use of appropriate measurement techniques and evaluation of results. Author

N65-33887# Joint Publications Research Service, Washington, D. C.
CLAD STAINLESS STEELS
S. A. Gladyrevskaya, L. V. Meandrov, S. A. Golovanenko, and A. A. Bykov 21 Sep. 1965 69 p refs Transl. into ENGLISH of 3 Chapters from the book, "Dvukhsloynyye Stali v Khimicheskom Mashinostroyenii," Moscow, "Mashinostroyeniye" Publishing House, 1965 p 81–147
(JPRS-32087; TT-65-32580) CFSTI: $3.00

A study is presented on corrosion resistance, fatigue strength, and engineering processes in the manufacturing of clad stainless steels. Discussions are included on clad steel passivity, heat treatment effects on clad steel corrosion resistance, intercrystalline corrosion, overall corrosion resistance in different corrosive media, point corrosion, welding behavior in a corrosive medium, corrosion under stress, fatigue strength in the absence and presence of stress concentrators, engineering properties of bimetals when pressure worked, characteristics of billeting and assembly operations involving bimetals, manual arc and automatic welding, and different articles made of clad steel. R.N.A.

N65-33897# Massachusetts Inst. of Tech., Cambridge. Casting and Solidification Section.
EFFECTS OF SOLIDIFICATION VARIABLES ON THE STRUCTURE OF ALUMINUM BASE INGOTS, JUNE 1963–1964
T. F. Bower, H. D. Brody, and M. C. Flemings 1 Jun. 1965 129 p refs
(Contract DA-19-020-ORD-5706A)
(AD-618413)

An analytic and experimental study was made of the factors influencing dendritic structure, microsegregation and porosity in aluminum-base alloys produced under various growth conditions. Apparatus designed for controlled ingot solidification

was used to study (a) interrupted solidification, (b) programed solidification, (c) unidirectional solidification, (d) solidification under vibration, (e) liquid metal feeding of solidification shrinkage, and (f) slow solidification with high local temperature gradient ("Grain Refinement Probe"). A detailed description has been given of the structure of columnar dendrites in aluminum–copper alloy. Four zones which exist near the chill surface are discussed; these zones result from various stages of growth of the columnar structure. Independent dendrite "elements" develop during growth from the chill. Some consequences of dendrite element formation are discussed. Columnar dendrites having two (100) directions preferentially aligned, producing a "doubly oriented" structure, are also discussed. Finally, analyses are given for pore formation in the solidification of aluminum alloys. Author

N65-33915# Phillips Petroleum Co., Bartlesville, Okla. Research and Development Dept.
EFFECT OF JP-5 SULFUR CONTENT ON HOT CORROSION OF SUPER ALLOYS IN MARINE ENVIRONMENT Progress Report No. 2
H. T. Quigg and R. M. Schirmer 31 Dec. 1964 85 p refs
(Contract NOw-64-0443-d)
(Rept.-3945-64R; AD-610196)

An exploratory program was completed to provide a basis for a subsequent factorial experiment to determine whether the maximum sulfur content of 0.40 weight percent, currently allowed in grade JP-5 aviation turbine fuel, is a safe level for the protection of turbine blade alloys used in high-performance engines. Specimens of six different superalloys mounted in a cascade holder were exposed to vitiated air from the Phillips 2-inch combustor during a five hour cyclic test. Operating conditions were varied to investigate the effect of gas temperature, pressure and velocity at the test specimens, combustor air-fuel ratio, sea salt ingestion rate, and test specimen position in the cascade. Evaluations were based upon metal loss, scale analysis and metallographic examination of the test specimens. Author

N65-33925# California Univ., Berkeley. Lawrence Radiation Lab.
INTERSTITIAL ORDERING OF CARBON IN TANTALUM
R. E. Villagrana and C. Thomas Feb. 1965 44 p refs
(Contract W-7405-ENG-48)
(UCRL-11782, Rev.)

The effect of interstitial carbon on the structure of tantalum was investigated by transmission electron microscopy and diffraction. Interstitial ordering was found, and the ordered structure was determined from computation and comparison with electron diffraction data. The superlattice structure is tetragonal, with a c/a ratio of 1.128, and an ideal composition of $Ta_{64}C$. Since the superlattice was determined from thin foils, it was necessary to compare the thin foil results with bulk specimens, alloyed to correspond to $Ta_{64}C$. Microscopic examination of bulk specimens showed many domain boundaries, separating regions in which the tetragonality associated with ordering was oriented in different directions. An analysis of these domain boundaries indicates that there are three possible types: coherent, semicoherent, and antiphase. Author

N65-33928# Los Alamos Scientific Lab., N. Mex.
STUDY OF ALLOYS OF THE RHENIUM–CARBON SYSTEM
A. I. Evstiukhin, Iu. G. Godin, S. A. Kokhtev, and I. I. Suchkov [1963] 10 p refs Transl. into ENGLISH from Met. i. Metalloved. Chistykh Metal. (USSR), no. 4, 1963 p 149–159
(LA-TR-64-31)

Alloys of the rhenium–carbon system were studied with respect to alloy preparation, phase diagrams, annealing, and macrohardness. Microphotographs of Re–C system cast alloys, and a table of macro- and microhardness for Re–C system cast and hardened alloys are presented. In addition schematic X-ray photographs of Re–C cast and annealed alloys are depicted. The change of hardness of the cast alloys is plotted, and a partial phase diagram of the Re–C system is given. The data obtained indicate the probable existence of rhenium carbide, but the conditions of existence for the compound cannot be explained yet. From the composition data it was found that by increasing the total carbon content in the alloys, the quantity of bound carbon, which may occur if the rhenium carbide compound exists, increases. The composition diagram presented cannot explain the sharp increase of the interplanar distance for alloys with a carbon content of more than 3.0 weight percent, and in the alloys with 35.7 and 37.1 atom percent C an unusually high microhardness, characteristic of carbides, was noted. L.S.

N65-33935# Commissariat de l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.
ELECTRON MICROSCOPE STUDY OF THIN BERYLLIUM LAMELLAE [OBSERVATION DE LAMES MINCES DE BERYLLIUM AU MICROSCOPE ELECTRONIQUE]
J. Beaudier-Antolin, J. M. Dupouy, and Y. Adda 1963 32 p refs In FRENCH; ENGLISH summary
(CEA-2394) CFSTI: HC $2.00/MF $0.50

Thin strontium beryllium lamellae are examined by electron microscopy after various treatments, together with other samples made up of Be–Fe at 1% and 0.2% iron. The strontium–beryllium is examined after annealing at 750° and 900° C, strongly cold-worked and quenched at 900° C. At 950° C the metal is perfectly annealed; at 750° C the polygonization is almost complete; the dislocations are arranged in dislocation walls in the prismatic planes, or in hexagonal lattices with non-dissociated nodes suggesting a high stacking defect energy. The cold-worked structure has a high dislocation density and already existing crystal walls. In the quenched state, the few dislocations are very straight and are aligned in the crystallographic directions. Iron-precipitation is studied in two alloys during tempering at 660° after quenching in salt water. The precipitate appears at the grain boundaries and then spreads through the matrix leaving a depleted zone in the neighborhood of the joints. Author

N65-33937# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.
THE USE OF BERYLLIUM AS A CANNING MATERIAL. THE PROBLEMS ARISING FROM THE BRITTLENESS OF THE METAL AND THEIR PRESENT SOLUTION [L'UTILISATION DU BERYLLIUM COMME MATERIAU DE GAINE. LES PROBLEMES POSES PAR LA FRAGILITE DU METAL ET LEURS SOLUTIONS ACTUELLES]
Michel Weisz and José Mallen 1964 15 p refs In FRENCH; ENGLISH summary
(CEA-R-2639) CFSTI: HC $1.00/MF $0.50

The brittleness of beryllium is studied in the interest of using this metal as a canning material for CO_2-cooled reactors with 600° C operating temperature. A serious lack of ductility at 600° C was discovered; apparently this problem can be solved by using cast beryllium of industrial purity and by eliminating sintering as a production process. Brittleness is also observed at low temperatures; in this case the ductility can be greatly increased by a stricter control of metallurgical factors. J.M.D.

N65-33966*# General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section.
ADVANCED REFRACTORY ALLOY CORROSION LOOP PROGRAM Quarterly Progress Report No. 1, Quarter Ending Jul. 15, 1965

R. W. Harrison and E. E. Hoffman 21 Jul. 1965 15 p
(Contract NAS3-6474)
(NASA-CR-54477) CFSTI: HC $1.00/MF $0.50 CSCL 11F

During the first quarter of the program, work proceeded on the topics abstracted below: Material vendors have been contacted, and the ordering of loop construction materials can commence promptly upon notification of the alloy selection by the NASA Project Manager. A lithium shipping container has been designed and constructed. High purity lithium will be purchased from Lithium Corporation of America. Mini-Flex Corporation, Lawndale, California, has demonstrated their capability to fabricate refractory alloy bellows, and an order for Cb-1Zr and T-111 bellows has been placed with this firm. Author

N65-33994# Joint Publications Research Service, Washington, D. C.
HANDBOOK OF SOVIET STEELS AND ALLOYS
20 Sep. 1965 65 p Transl. into ENGLISH from Russian
(JPRS-32070; TT-65-32563) CFSTI: $3.00

A listing of Soviet steels and alloys and their chemical compositions which was compiled from scientific and technical publications is reported. Data are presented under the following classification: *EI* (a factory designation for experimental steels produced by the Elektrostal' Plant; *EP* (representative of steels produced primarily for purposes other than welding wire); *EYa* (chromium-nickel, austenitic stainless steels); and *EZh* (chromium, martensitic, and ferritic stainless steels). In addition to the factory designation, Soviet steels and alloys are also identified by a designation which is an abbreviated nominal composition-designation system. Although the handbook does not include all the known Soviet steels and alloys, it represents a good cross section of materials used in various branches of Soviet industry. S.C.W.

N65-34012# Honeywell, Inc., Hopkins, Minn. Research Center.
OBSERVATIONS OF DISLOCATIONS IN $CaWO_4$ BY TRANSMISSION ELECTRON MICROSCOPY Twenty-ninth Technical Report
A. Arbel and R. J. Stokes Jul. 1965 32 p refs
(Contract Nonr-4076(00))
(HR-65-267; AD-618212)

The distribution of dislocations in deformed calcium tungstate was studied by electron transmission microscopy. The photomicrographs confirmed earlier optical observations that (001) ⟨100⟩ is the slip system of this material from 500°–900° C. Screw dislocations, long edge dislocation dipoles, quadrupoles and tangles of dislocations were observed in foils prepared from specimens deformed at 500° C. Specimens deformed at 700° showed similar features, except that many of the long dipoles had split into long strings of prismatic loops. At 900° C the loops were more isolated and sometimes grew to a diameter exceeding the thickness of the foil. Many single dislocations could also be seen with nearly pure edge or screw orientation. Two models are proposed for quadrupole formation and their relative stability considered. Strain hardening is thought to be due to the interaction of dislocations with multipoles and prismatic circular loops. Author

N65-34021# British Welding Research Association, Cambridge (England).
SOME METALLURGICAL IMPLICATIONS OF WELDING STRUCTURAL STEELS
R. G. Baker, F. Watkinson, and T. Boniszewski Dec. 1964 25 p refs

A summary of recent work on the welding of low alloy steels is presented. The different welding problems, namely heat affected zone hot tearing, heat affected zone cold cracking, weld metal solidification cracking, and poor weld metal toughness are briefly described, and the experimental work performed on hot tearing and heat affected zone cracking is reviewed. It was concluded that: (1) hot tearing in low alloy steels is the result of metallurgical burning; susceptibility depends on the carbon level; (2) low alloy steels can be classified according to their transformation characteristics as determined under simulated heat affected zone conditions; and (3) steels of high hardenability and relatively low susceptibility to hydrogen cracking are difficult to crack if the specimen has a close fitup with low preheating temperatures. G.G.

N65-34027 National Research Corp., Cambridge, Mass.
ADHESION AND FATIGUE PROPERTIES OF MATERIALS IN VACUUM
M. J. Hordon and L. R. Allen *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 13 p refs (See N65-34025 22-11)
(Contracts NASw-734; NASw-962)

To evaluate certain property changes expected in space, tests are being conducted on high vacuum fatigue and metallic adhesion and welding. Studies dealing with the pressure dependence of fatigue in aluminum indicate that in the absence of air fatigue life improves two- to five-fold depending on the applied stress level. Doubling the cyclic frequency from 25 to 50 cps produces a negligible change in fatigue life. Fatigue crack formation appears to be relatively insensitive to pressure level. Multiple cracks are observed in samples fatigued in air and at 1×10^{-3} torr, but only a single fracture is observed at 2×10^{-7} torr. Fatigue resistance in vacuum increases steadily as fatigue stress decreases from about 13 500 to 8500 psi. It was found that adhesion force increases with abrasion time in studies of oxide films. Low strength ductile material such as annealed aluminum and copper exhibit substantial self-adhesion after cleaning. The sensitivity of solid adhesion welding to the plastic flow criterion is graphed and shows that the softer, more ductile materials adhere more than do the harder alloys when a constant stress is applied. M.W.R.

N65-34049# Lockheed Missiles and Space Co., Sunnyvale, Calif. Materials Sciences Lab.
INVESTIGATION OF MODIFIED SILICIDE COATINGS FOR REFRACTORY METAL ALLOYS WITH IMPROVED LOW-PRESSURE OXIDATION BEHAVIOR Second Progress Report, 1 Sep.–30 Nov. 1964
Dec. 1964 41 p ref
(Contract AF 33(615)-1732)
(M-03-64-2; AD-465713)

This report documents the continuation of an investigation to stabilize the disilicide coatings for tantalum and niobium against degradation in low-pressure oxidizing environments by substituting the intermediate silicide Me_5Si_3 for the $MeSi_2$ (Me stands for Ta or Nb) and by alloying these silicides with aluminum to ternary compounds $Me_5(Si, Al)_3$ and $Me(Si, Al)_2$, respectively. Influence of activating halide salt composition, time and temperature of treatment, and nature of the diluent inert oxide on the pack cementation process for deposition of $TaSi_2$ and Ta_5Si_3 coatings on tantalum from Si and $TaSi_2$ sources was studied. Structure and thickness of the coatings were strongly dependent on the halide present in the system, with the fluoride producing the thickest $TaSi_2$ and Ta_5Si_3 coatings. However, side reactions of the halide with the pack diluent contaminates the coatings with surface glass formation and strongly adherent particles. Investigation of conversion of pre-deposited disilicide coatings into the intermediate disilicide by high temperature diffusion treatment showed a strong

dependence of the structure of the converted coatings on the environment as well as time and temperature of the process. Nb_5Si_3 structures showing bands of what may be three different stoichiometric Nb/Si ratios in the compound are produced when converting the $NbSi_2$ coating under reduced pressure of helium. The instability of the coating surfaces causes considerable difficulty in optical measurements of the sample temperature. Author

N65-34057 Pressure Technology Corp. of America, Woodbridge, N. J.
AN INVESTIGATION OF Be AND W ALTERED BY HIGH-PRESSURE DEFORMATION Engineering Progress Report No. 2, 7 Mar.–7 May 1965
[1964] 11 p
(Contract NOw-64-0180-c)
(AD-614129)

Tensile tests have been conducted on polycrystalline beryllium and tungsten, and fluid-to-fluid extrusion on polycrystalline beryllium. Ductility was observed in beryllium at pressures of about 300 000 psi. Author

N65-34066# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
APPLICATION OF STATISTICAL THEORY OF DISLOCATIONS TO DERIVATION OF BASIC RELATIONSHIPS FOR STRENGTHENING CURVES
N. S. Akulov and A. K. Shukevich 14 Jul. 1965 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Belorussk. SSR, v. 7, no. 7, 1963 p 453–455
(FTD-TT-65-346/1+2+4; AD-618318)

A formula was derived for strengthening curves, and utilized within the framework of the statistical theory of dislocations. This series of equations consequently describes the strengthening curve and relates to the extreme cases, in that it is valid for pure metals, and also for alloys with a great number of dispersion particles. W.M.R.

N65-34104# Massachusetts Inst. of Tech., Cambridge.
INVESTIGATION OF FRACTURE IN CONNECTION WITH HOT DEFORMATION PROCESSING OF METALS Letter Report No. 3, 15 Jan.–15 Mar. 1965
Nicholas J. Grant, Peter Bridenbaugh, Barry Greene, and Robert Kane [1965] 3 p
(Contract NOw-65-0108-d)
(AD-462956)

Studies of metals and alloys with a phase transformation are reported. The following products were received: Armco ingot iron (slab and rolled sheet), Ferro-Vac iron (ingot and wrought), Titanium Ti-55 (cast ingot and wrought barstock), and Ti-6Al-4V alloy (cast ingot and wrought bar stock). Test specimens are being machined from the wrought materials; and the ingots, slabs, and similar heavy sections were cut into smaller shapes for preparation of test specimens. A study of the microstructure of Udimet-700 specimens was made which focused on determining the effects of temperature and time of exposure on cast structure. Four zones of coring and change of grain structure were observed and several phases identified. Based on a number of preliminary high strain rate tests of cast molybdenum structures at 3000° 3800° , and 4200° F, a series of additional tests are planned to extend the strain rate range, and to include additional temperatures. Also planned are a series of interrupted tests in an effort to detect the origin of failure, and to study crack growth leading to fracture. The high strain rate machine was checked out, calibrated, and is now in operation. Auxiliary equipment to the high strain rate machine was also constructed. S.C.W.

N65-34113# Pratt and Whitney Aircraft, Middletown, Conn.
RECOVERY AND RECRYSTALLIZATION OF COLUMBIUM AND SEVERAL COLUMBIUM–ZIRCONIUM ALLOYS
C. E. Carlson and E. J. Delgrosso Sep. 1965 34 p refs
(Contract AT(30-1)-2789)
(PWAC-465)

The recovery and recrystallization characteristics of cold worked columbium and columbium–zirconium alloys having nominal compositions of Cb-1 Zr, Cb-3 Zr and Cb-5 Zr were studied. Activation energies for recovery were determined for the Cb-1 Zr, Cb-3 Zr, and Cb-5 Zr alloys. The activation energies for the initiation of recrystallization were calculated for Cb (2 interstitial levels), Cb-1 Zr (2 interstitial levels), Cb-3 Zr, and Cb-5 Zr. Electron transmission metallography of Cb-1 Zr alloy indicated that during recrystallization, complex dislocation interactions occurred which were strongly influenced by precipitates of ZrO_2. Author

N65-34213# Argonne National Lab., Ill.
EXAMINATION OF IRRADIATED Ag–In–Cd ALLOYS
C. F. Reinke May 1965 19 p refs
(Contract W-31-109-ENG-38)
(ANL-6883) CFSTI: $1.00

Extruded cast and extruded powder specimens of Ag-15w/oIn-5w/oCd alloy, plated with 25 μ of nickel or 25 μ each of copper plus nickel, were irradiated for 47 effective full-power days at approximately 300° C in a lattice position of the Engineering Test Reactor. The extruded cast alloys exhibited 0.2% yield strengths, ranging from 114 to 140 kg/cm^2 in the unirradiated condition, and 96 to 150 kg/cm^2 after irradiation. The percent elongation and reduction in area in both cases normally ranged from 50 to 60%. The 0.2% yield strength for the extruded powder alloys ranged from 190 to 228 kg/cm^2 in the unirradiated condition, and 214 to 242 kg/cm^2 after irradiation. There was a noticeable improvement in both the percent elongation and reduction in area of the extruded powder specimens, the postirradiation values being approximately twice the unirradiated values of 10%. Author

N65-34247*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
ROOM TEMPERATURE TENSILE BEHAVIOR OF 100 ORIENTED TUNGSTEN SINGLE CRYSTALS WITH RHENIUM IN DILUTE SOLID SOLUTION
Marvin Garfinkle Washington, NASA, 1965 22 p refs Presented at the 4th Symp. on Refractory Metals, Refractory Metals Comm., AIME, 3–5 Oct. 1965
(NASA-TM-X-52132) CFSTI: HC $1.00/MF $0.50 CSCL 11D

Addition of rhenium to oriented tungsten single crystals increases the proportional limit stress and decreases the flow stress of the crystals. Work hardening is practically nonexistent in the 9 a/o rhenium alloy until necking occurs. Discontinuous yielding occurs at 5 a/o rhenium, and the magnitude of the yield-point drop increases with increasing rhenium content. Yielding and flow behavior of the 9 a/o rhenium oriented crystals is similar to that of unalloyed oriented tungsten crystals but at a much lower stress level. Alloys with 5 a/o or more rhenium neck before failure which is similar to behavior in the deformation of oriented unalloyed tungsten crystals. Deformation of unalloyed crystals apparently involves a different slip than does the rhenium alloy. The effect of dilute rhenium additions and the orientation effect observed in unalloyed tungsten are interpreted in terms of the orientation dependence of the sites occupied by the interstitials in the stress field of dislocations when the lattice is elastically deformed and in terms of effects of rhenium additions on interstitial distribution in tungsten. M.W.H.

N65-34248*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SOLID SOLUTION AND CARBIDE STRENGTHENED ARC MELTED TUNGSTEN ALLOYS

Peter L. Raffo and William D. Klopp Washington, NASA, 1965 22 p refs Presented at the 4th Symp. on Refractory Metals, Refractory Metals Comm., AIME, French Lick, Ind., 3–5 Oct. 1965

(NASA-TM-X-52131) CFSTI: HC $1.00/MF $0.50 CSCL 11D

The effect of carbon additions on the high temperature strength of tungsten and tungsten alloys was investigated. Solid solution strengthened alloys (W–Hf, W–Ta–Re, W–Ta–Hf, W–Re–Hf, and W–Cb–Hf) and carbide strengthened alloys (W–C, W–Cb–C, W–Ta–C, W–Ta–Re–C and W–Hf–C) were the alloy systems studied. They were prepared by an arc melting process. It was found that the most effective solid solution strengthener in tungsten in the temperature range of 2500° F to 4000° F is hafnium. Tantalum and niobium are less effective, and rhenium is the least effective. The same order holds in creep and short time tensile tests. The relative solid solution strengthening effects can be correlated with the difference in atom size between tungsten and the solute atom, and the strengths of ternary solid solution alloys can be represented as the sum of the individual strengthening effects found in the binary alloys at 2500° to 3500° F. Tungsten-tantalum-rhenium alloys showed greatly enhanced resistance to recrystallization at 3500° F L.S.

N65-34249*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

ULTRAHIGH-VACUUM CREEP BEHAVIOR OF COLUMBIUM AND TANTALUM ALLOYS AT 2000° AND 2200° F FOR TIMES GREATER THAN 1000 HOURS

Robert H. Titran and Robert W. Hall Washington, NASA, 1965 20 p refs Presented at the 4th Symp. on Refractory Metals, Refractory Metals Comm., AIME, French Lick, Ind., 3–5 Oct. 1965

(NASA-TM-X-52130) CFSTI: HC $1.00/MF $0.50 CSCL 11D

A screening study of the long-time, high temperature (2000° F and 2200° F) creep behavior of niobium and tantalum base alloys was conducted under conditions of ultrahigh-vacuum (10^{-8} to 10^{-9} torr). The results of long-time creep tests conducted on 0.030-in. thick recrystallized fine-grained sheet specimens at common stress-to-density ratios of 2.6×10^4 and 1.3×10^4 in. at 2000° F and 2200° F respectively, indicate that the tantalum alloy T-222 has outstanding creep resistance under the conditions investigated. At 2000° F and a stress level of 15,900 psi (2.6×10^4 in.), T-222 exhibited only 0.10-percent total creep strain after 5000 hr of testing. Other creep data are given; and tables of data on the chemical composition of the alloys studied, and on the hardness, grain diameter, and annealing temperature of the alloy after recrystallization are presented. Various curves indicating creep behavior for tested alloys are given, and data from vacuum fusion analysis for oxygen on ultrahigh-vacuum creep specimens after testing are tabulated. L.S.

N65-34250*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DUCTILITY AND STRENGTH OF DILUTE TUNGSTEN–RHENIUM ALLOYS

William D. Klopp, Walter R. Witzke, and Peter L. Raffo Washington, NASA, 1965 22 p refs Presented at the 4th Symp. on Refractory Metals, Refractory Metal Comm., AIME, French Lick, Ind., 3–5 Oct. 1965

(NASA-TM-X-52134) CFSTI: HC $1.00/MF $0.50 CSCL 11D

The extent of the improvement in ductility and the effect of composition and melting method upon the ductility and other properties of tungsten-rhenium alloys are considered. The compositions selected for study included eight electron beam (EB) melted and five arc-melted dilute alloys containing from 1.00 to 9.05 percent rhenium. In addition, an EB-melted W-24.0 Re alloy and an arc-melted commercial W-25.6 Re alloy were included for comparison with dilute alloys. Results indicate that improved ductility may be related, in part, to the higher purity achieved by EB melting. The best ductilities were obtained on sheet cleaned several times during rolling at temperatures of 1750° to 2400° F. Annealing at 3600° F significantly increased the ductile-brittle bend transition temperatures of both EB-melted and arc-melted alloys. Rhenium additions up to 9.05 percent strengthened tungsten at elevated temperatures in both short-time tensile and long-time creep. G.A.L.

N65-34251*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CRACK INITIATION AND PROPAGATION IN NOTCHED FATIGUE SPECIMENS

S. S. Manson and M. H. Hirschberg Washington, NASA, 1965 31 p refs Presented at Intern. Conf. on Fracture, Sendai, Japan, 12–17 Sep. 1965

(NASA-TM-X-52126) CFSTI: HC $2.00/MF $0.50 CSCL 11F

An approximate analysis has been developed whereby the number of cycles required to start an "engineering size" crack and the number of cycles required to propagate this crack to failure could be estimated for a notched specimen from a knowledge of the fatigue behavior of unnotched specimens. Cracks are assumed to occur at the root of a notch in a number of cycles dependent only on the localized surface strain and then propagate in a manner similar to those in an unnotched specimen. Reasonably good predictions of crack initiation, crack propagation, and total life were obtained for annealed 4340 steel and 7075 T6 aluminum notched specimens and stress concentration factors of 2 and 3. Author

N65-34252*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CORROSION OF REFRACTORY ALLOYS BY REFLUXING POTASSIUM

C. M. Scheuermann Washington, NASA, 1965 18 p refs Presented at the 4th Symp. on Refractory Metals, Inst. of Metals Div., AIME, French Lick, Ind., 3–5 Oct. 1965

(NASA-TM-X-52136) CFSTI: HC $1.00/MF $0.50 CSCL 11F

A summary of corrosion capsule studies to test the resistance of niobium- and tantalum-base tubing alloys to refluxing potassium over the temperature range 1800° to 2400° F, and for times up to 4000 hours, is presented. The various capsules, containing about 1 1/4 cc of potassium, were tested in high-vacuum chambers at pressures of 10^{-7} to 10^{-8} torr. Metallographic examinations were made of all specimens. It was observed that most alloys exhibited surface roughening, or etching. Ungettered alloys were more severly attacked and exhibited solution and intergranular penetration. Gettered alloys, with the exception of Cb-1Zr, showed only relatively slight effects of potassium corrosion. After 2000 hrs at 1800° F, Cb-1Zr capsule walls exhibited up to 7.0 mils of intergranular attack and grain removal at the liquid-vapor interface. Vacuum fusion analyses for oxygen showed a greater concentration of oxygen in the bottom sections of several capsules than in the top sections. G.G.

N65-34300*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A CONFIGURATION MODEL FOR THE THERMAL AND ULTRAVIOLET STABILITIES OF α-Al_2O_3

John B. Schutt and Buford A. Macklin [1963] 22 p refs Submitted for Publication

(NASA-TM-X-51853) CFSTI: HC $1.00/MF $0.50 CSCL 11F

This investigation was carried out to determine the thermal and ultraviolet stabilities of α-Al_2O_3 in a vacuum environment in order to gain some knowledge about the behavior of anodized aluminum in similar environments. α-Al_2O_3 was selected because of its reproducible responses to the formulation of the characteristic brown coloration. It was found that α-Al_2O_3 could be browned significantly at 350°C at 10^{-4} torr, as well as in a 60°C thermal environment at 10^{-7} torr under one solar constant of ultraviolet energy. In all cases bleaching in air was observed to occur significantly at about 350°C. A wavelength of 360 μ was found to give partial bleaching under ambient conditions. Using these observations, a configurational coordinate scheme was worked out to explain the behavior. In addition, a brief discussion of the surface chemistry is included. Author

N65-34301*# Aluminum Co. of America, New Kensington, Pa. Alcoa Research Labs.
DEVELOPMENT OF A HIGH STRENGTH ALUMINUM ALLOY, READILY WELDABLE IN PLATE THICKNESSES, AND SUITABLE FOR APPLICATIONS AT −423°F (−253°C). PHASE III: EXPERIMENTAL PLAN Progress Report II
R. W. Westerlund 16 Jun. 1964 31 p
(Contract NAS8-5452)
(NASA-CR-56813) CFSTI: HC $2.00/MF $0.50 CSCL 11F

The effect of Cd and/or Sn on the properties of 2000 series alloys was studied. Presented are comparative data on the properties of the 2000 and 7000 series alloys. It was shown that both groups approach the minimum strength and minimum notch toughness goals. The major difference between the two alloy groups was the temperature sensitivity of the notch toughness. Studies on the effect of aging treatments on the notch toughness of the Al-Zn-Mg alloys demonstrated that: (1) a high solute alloy in an underaged temper appeared to have slightly lower notch toughness than an alloy with less solute at full strength, and (2) notch toughness appears to decrease abruptly during isothermal ageing at strengths near or just beyond the maximum. The effect of Zr on the microstructure of a 7000 series alloy was studied using the electron microscope to determine how Zr improves notch toughness. Zirconium was shown to retard recrystallization. A program to determine if notch toughness is dependent on the degree of recrystallization did not reveal any direct connection between notch toughness and the degree of recrystallization. S.C.W.

N65-34319# Ohio State Univ. Research Foundation, Columbus.
A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM Quarterly Report, 17 Dec. 1964–16 Mar. 1965
R. W. Staehle, F. H. Beck, M. G. Fontana, and J. P. Hirth 5 Apr. 1965 18 p
(Contract AT(11-1)-1319)
(COO-1319-24)

A model for cracking is developed from stress corrosion experiments with iron–nickel–chromium alloys, and studies have been made of the tensile properties of the materials used in these experiments. Conditions resulting in specimens subjected to stress are compared to nonstressed conditions for various alloys; and it is found that, except in the case of very low alloy materials, there is very little oxidation, pitting, or other chemical attack in the absence of stress. The presence of stress promotes oxidation, cracking, and pitting, and these attacks vary with the alloy used. Cracking is found to be both intergranular and transgranular. Scoping studies were initiated to determine the effects of water-oxygen-chloride-environment on the alloys, and it is shown that there is generally very little attack on the stressed specimens in a water environment. Other environments appear to play an important role according to preliminary studies. Tensile stress, yield stress, and percentage elongation are tabulated at room temperature for the various alloys. M.W.R.

N65-34326# Brown Univ., Providence, R. I. Div. of Engineering.
OBSERVATIONS ON THE INITIATION OF FRACTURE IN ALUMINUM–SILICON ALLOYS
A. Gangulee and J. Gurland Sep. 1964 21 p refs
(Contract AT(30-1)-2394)
(TR-8)

The cracking of silicon particles, during the early stages of deformation of Al–Si alloys, occurs progressively over a range of stress. The fracture probability of the particles is proportional to a stress-structure parameter: $\sigma\left(\frac{d^{1/2}}{f^{1/3}}\right)$, based upon a simple dislocation model. The experimental evidence indicates preferred cracking of the larger particles and, in general, supports the view that cracks in the silicon particles are preceded by slip in the matrix. Author

N65-34340# Solar, San Diego, Calif.
DEVELOPMENT OF PROTECTIVE COATINGS FOR TANTALUM BASE ALLOYS
A. R. Stetson, H. A. Cook, and V. S. Moore Wright-Patterson AFB, Ohio, AF Mater. Lab., Jun. 1965 166 p refs
(Contract AF 33(657)-11259)
(AFML-TR-65-205, Pt. I; AD-469639)

The unmodified silicide coating on the Ta–30Cb–7.5V alloy in a silicon weight of 25.2 mg/cm^2 protected the substrate from oxidation for over 100 hours at 1800°F and over 40 hours at 2700°F. All pack modifiers (Ti, V, W, Mo) decreased the oxidation resistance of the silicide coating on this alloy. On the 90Ta–10W alloy, only heavy modification of the substrate in two-cycle processes (modifier first and silicon second) was capable of affording significant protection to the substrate. Effective modification required the deposition of 15 to 30 mg/cm^2 of Ti, Ti–W, Ti–Mo, or Ti–Cr prior to the deposition of silicon. The longest oxidation life of a modified silicide on the 90Ta–10W alloy at 2700°F was 50 hours, and was obtained from a pure titanium pack modifier with a titanium deposit weight of 26.0 mg/cm^2. The pure titanium pack provided severe sintering problems and a 90 volume percent titanium –10 volume percent tungsten (67.8 weight percent titanium –32.2 weight percent tungsten) prealloyed pack was used which minimized sintering and provided only slightly inferior high-temperature oxidation resistance. The low-temperature oxidation resistance (1800°F) of the coated 90Ta–10W alloy was only fair, ranging up to 50 hours for the Ti–W modified coating. The highest 1-hour use temperature for the coated 90Ta–10W alloy is 3000°F. Author

N65-34353# Centre National de Recherches Metallurgiques, Liege (Belgium).
STUDY OF EMBRITTLEMENT BY PLASTIC FATIGUE OF STEELS FOR REACTOR VESSELS Quarterly Report No. 5, Jan. 1–Mar. 31, 1965
Apr. 1965 27 p ref
(Contract EURATOM-005-63-12 TEEB)
(P/70/; EURAEC-1349) CFSTI: HC $2.00/MF $0.50

The study of embrittlement by plastic fatigue of the three steels, utilized for research, has been pursued, both by means of the side bend test after fatigue by alternating bending and by means of impact strength tests on Charpy V test-pieces, taken from the samples previously submitted to monoaxial plastic fatigue under tension and compression. The tests have brought out a rather pronounced influence of the small numbers

of fatigue cycles. In some cases, it has been noticed that the imposition of bearings to maximal stress for damage by bend fatigue led to fairly perceptible rises of the transition temperature. Whether it be a question of damage at 20° C or at 300° C, the maximal values of the shift of the side bend test transition curve registered up to now, nevertheless scarcely exceeded 30° C. Author

N65-34370# Douglas Aircraft Co., Inc., Newport Beach, Calif. Astropower Lab.
STRESS CORROSION IN MARTENSITIC HIGH STRENGTH STEELS Quarterly Report, Nov. 1964–Jan. 1965
C. B. Gilpin, S. M. Toy, and N. A. Tiner Feb. 1965 43 p refs
(Contract AF 33(657)-10744)
(Rept.-132-Q7; AD-463766)

Electron microautoradiographic experiments have indicated that cathodically charged hydrogen in the form of tritium) segregated to prior austenite grain boundaries in 4340 steel. After aging at room temperature for two weeks, the tritium was no longer segregated at boundaries but was distributed throughout the material. It was not possible to determine if the tritium concentration was decreased or if the tritium was just redistributed. Metallographic studies of cracks indicate that cracks initiate below the surface at inclusion site outcroppings on the surface. The crack front in the intergranular region of propagation appears to be relatively smooth, whereas in the transition portion it is quite jagged. The prinpal electrochemical processes taking place during the stress corrosion test are attributed to two cathodic reactions, hydrogen reduction and oxygen ion reduction, which cathodically control the anodic iron oxidation reaction. It is based on the analysis of the effect of oxygen content, pH and tempering on the polarization curves determined for marquenched 4340 steel. These results also form the basis for deriving the electrochemical aspects of stress corrosion cracking by coupling the most active redox reactions. A polarization curve on EF 18% nickel maraging steel in oxygenated 3% NaCl pH 1.5 was determined. Author

N65-34423# Thiokol Chemical Corp., Huntsville, Ala.
THE EVALUATION OF NOZZLE MATERIALS Phase Report
S. P. Gualillo 7 Apr. 1965 76 p refs
(Contract DA-01-021-ORD-11919)
(Rept.-19-65; AD-461305)

An engineering study, conducted to evaluate nozzle materials, dealt specifically with throat materials, and was based on actual firing tests of rockets throughout the industry. The objectives were to provide an evaluation of this compilation of data, and to analyze the relative performance of various nozzle throat materials tested. Four hundred and nine tests were tabulated and presented; also included are abstracted test data from 86 reports representing work accomplishment for a 6-year period. Erosion rate on the throat radius was used as the criteria due to variations in test procedures, environment, and comprehensiveness of data. W.M.R.

N65-34429*# Battelle Memorial Inst., Columbus, Ohio.
FATIGUE BEHAVIOR OF MATERIALS FOR THE SST–ELECTRON FRACTOGRAPHIC STUDIES Final Report
D. W. Hoeppner, W. R. Warke, W. S. Hyler, and J. L. Mc Call 31 Jul. 1965 44 p refs
(Contract NASI-4460)
(NASA-CR-66011) CFSTI: HC $2.00/MF $0.50 CSCL 11F

The use of electron microscopic fractography as the primary research tool to determine the influence of various metallurgical variables on the fracture surface appearance of specimens of Ti–8Al–1Mo–1V employed for fatigue crack propagation studies is described. At low stresses, the inclusions and other stress concentrators act as local fatigue crack initiation sites. At higher stresses, the role of inclusions appear less pronounced and in some cases insignificant. Stereoscopic examination revealed the fracture surface to be much rougher than imaginable from single fractographs. Inclusions contributed significantly to the gross roughness of the fracture surface. However, other crystallographic factors also appeared important because the failure plane frequently varied in elevation and tilt from one grain the the next. Local crystallographic variations were observed to have a greater influence on the growth of cracks at low growth rates than at high ones. Factors found to influence the correspondence of the macroscopic with microscopic growth rate are: resolution of the technique, location of measurements with respect to sheet thickness, and local variation in microstructure. R.R.D.

N65-34431*# Battelle Memorial Inst., Columbus, Ohio.
THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF TYPE 316 STAINLESS STEEL FROM 0 TO 1800F
J. Matolich, Jr. 15 Sep. 1965 32 p refs
(NASA Order C-46539-A)
(NASA-CR-54151; BATT-7096) CFSTI: HC $2.00/MF $0.50 CSCL 11F

Thermal conductivity and electrical resistivity measurements were made on two stainless steel specimens from different heats. Within experimental error there is no significant difference between the two specimens except at 800° F, where the data suggest a solid state reaction. Thermal conductivity values range from 7.43 to 17.0 Btu $hr^{-1}ft^{-2}ft\ °R^{-1}$ over the temperature range 0° to 1800° F. Over the same temperature range the electrical resistivity values range from 74 to 120 microhm-cm. Author

N65-34452# Pratt and Whitney Aircraft, Middletown, Conn.
CAVITATION DAMAGE TESTS WITH ROTATING DISK IN WATER
L. K. Knudsen Sep. 1965 132 p refs
(Contract AT(30-1)-2789)
(TIM-894)

The cavitation damage resistance of alloys of aluminum, niobium, tantalum, molybdenum and stainless steel were evaluated in water using a rotating disk apparatus that simulated the cavitation vortex patterns encountered in pumps operating at high suction specific speed. The alloys in decreasing order of cavitation resistance were Ta–8W–2Hf, Nb–18W–8Hf, Ta–10W, 316 S.S., Mo–.5Ti, Al–4Cu–.7 Mn–.5Mg, and Al–2.5Mg–.25Cr. The damage resistance order does not follow a single concept of strain energy, yield point or hardness, but appears to be a combination of physical properties and phase structure. Photomicrographs show predominant intergranular cracking for the molybdenum alloy and transgranular cracking for the remaining alloys tested. The second phase precipitate in the aluminum alloy appears to hinder the errosion of material. The small variation in grain size of the heat treated Nb–1Zr alloy showed small variation in damage resistance with the largest grain structure providing the least erosion. Correlation curves of volume loss as a function of velocity are presented for all materials tested. Author

N65-34491# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.
EFFECTS OF ADSORPTION ON STRENGTH Technical Report No. 5
A. R. C. Westwood Aug. 1965 40 p refs Submitted for Publication *Its* Tech. Rept.-65-8
(Contract DA-31-124-AROD-63)
(AROD-3937-6; AD-620027)

Adsorbed surface-active species can influence the strength of materials by affecting cohesion and dislocation behavior at the surface, and possibly by affecting dissolution behavior in mildly corrosive environments. These and other possibilities are discussed in connection with such phenomena as liquid metal embrittlement, stress-corrosion cracking, complex-ion embrittlement, Rebinder effects, the adsorption-locking of dislocations, and the photo- and electromechanical effects.

Author

N65-34501*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STRENGTH COMPARISON OF FLAWED SINGLE-LAYER AND MULTILAYER AISI 301 STAINLESS-STEEL PRESSURE VESSELS AT CRYOGENIC TEMPERATURES

William S. Pierce Washington, NASA, Oct. 1965 21 p refs
(NASA-TN-D-2949) CFSTI: HC $1.00/MF $0.50 CSCL 11F

An experimental investigation was conducted to determine the strengths of single-layer and multilayer scale model tanks of AISI 301 stainless steel containing sharp notches and having the same total wall thickness. Material was used for both the single-layer and multilayer tanks having 60- and 70-percent cold reduction. The tanks were pressurized to burst at −320° and −423° F. Smooth, sharp-edge-notch, and sharp-center-notch tensile specimens were tested to provide data for correlation with the tank strengths. The results indicate that an increase of burst stress of approximately 15 to 20 percent for the flawed multilayer tanks can be obtained relative to the comparable single-layer flawed tanks. Three multilayer tanks exhibited failure of the outer layer prior to complete tank failure. This characteristic could provide a fail-safe type of design. Although the multilayer method of construction reduced the notch sensitivity in the tanks, the more notch-ductile 60-percent cold-reduced material was still found to permit higher burst strengths than the 70-percent cold-reduced material where there was a sharp notch in the tank wall. Author

N65-34511# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.

CONDITIONS FOR INTERACTION OF CYCLIC TORSION WITH AXIAL LOADS

Maria Ronay Aug. 1965 36 p refs
(Contract Nonr-266(91))
(TR-25; AD-469932)

The continuum mechanical theory of second order strain accumulation and the theory of interaction of second order extension due to cyclic torsion and sustained tension is summarized. The predicted linear interaction of second order extension due to cyclic torsion and sustained tension is proved by experiments on superpure aluminum, copper, Armco iron and 70 30 brass. It has been found that the conditions for interaction between cyclic torsion and axial stress are that the torsion angle be larger than the fatigue limit (elastic limit) and the applied tensile stress be larger than the Bauschinger yield limit in tension produced by reversed cyclic torsion. Author

N65-34529 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CALCULATION OF RATE OF VAPORIZATION OF METAL FROM CYLINDRICAL VESSELS INTO A VACUUM AND MASS SPECTROMETRIC INVESTIGATION OF VAPOR PRESSURES OF METALS AND ALLOYS

Yu. N. Lyubitov 22 Jul. 1965 15 p refs Transl. into ENGLISH from Konf. Fiz.-Khim. Osnovam Proizv. Stali (USSR), 1964 p 358–365
(FTD-TT-65-611/1+2+3+4; AD-619464)

An investigation was made of conditions of vaporization from a cell of cylindrical shape for the case of monomeric and dimeric particles of vapor. It is shown how the calculations which are made can be applied for investigations of processes of vaporization on the mass spectrometer. TAB

N65-34541# Army Materials Research Agency, Watertown, Mass. Materials Technology Div.

INVESTIGATION OF THE FORMABILITY CHARACTERISTICS OF THE POLYPHASE TITANIUM ALLOY Ti-6Al-6V-2Sn-4Zr

Arthur M. Ayvazian and Robert M. Colton Mar. 1965 20 p refs
(AMRA-TR-65-05; AD-614637)

Studies were conducted on a 1000-pound ingot of titanium alloy Ti-6Al-6V-2Sn-4Zr, in order to determine the metal working characteristics. Five actual titanium components were formed from this material by extrusion and press forming. The results from these tests indicated that the ease of formability compared favorablly with that of the commercial alloy Ti-6Al-6V-2Sn. The mechanical properties of test specimens taken from parts formed from both alloys disclosed that for the alloy Ti-6Al-6V-2Sn-4Zr the tensile strength was substantially higher and ductility and toughness were lower at the same yield strengths. Author

N65-34542# Case Inst. of Tech., Cleveland, Ohio. Dept. of Metallurgy.

INTERFACE MOTION IN PHASE TRANSFORMATIONS. BAINITE TRANSFORMATIONS IN HYPOEUTECTOID STEELS

R. H. Goodenow, R. H. Barkalow, and R. F. Hehemann Feb. 1965 35 p refs
(Contract Nonr-1141(15))
(TR-2; AD-611092)

Kinetic and structural aspects of bainite formation have been studied by stepped transformation experiments. Growth of lower bainite stops if the temperature is raised to the upper range and upper bainite either stops growing or grows at a rate substantially below that of lower bainite when the temperature is reduced suddenly to the lower range. It is concluded that the internal structural differences which characterize upper and lower bainite exert a significant influence on the rate at which these products develop. In the steels studied in this investigation, lower bainite plates thicken from one side only. These plates exhibit a substructural unit oriented at an angle to the growth direction and these units appear to nucleate at the immobile side of the plates. Edgewise growth rates measured on the hot stage thus may reflect primarily the rate of nucleation of these substructural units. A similar situation may prevail in the growth of upper bainite needles. Author

N65-34574# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE CHARACTER OF CRYSTAL-LATTICE DISTORTIONS IN THE INITIAL STAGE OF THE ORDERING PROCESS OF CoPt ALLOYS

Yu. D. Tyapkin and K. M. Yamaleyev 22 Jul. 1965 10 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, (Moscow), v. 155, no. 6 p 1310–1313
(FTD-TT-65-392/1+2+4; AD-618903)

Monocrystals of the CoPt alloy were studied by X-ray diffusion dispersion for changes in their crystalline structure during ordering processes. The crystals were preliminary tempered at 1,000° to 1,100° C, and the ordering processes were mostly studied after treatments at 450° C for one hour, or at 600° C

for 15 minutes. Eroded superlattice maxima of the monocrystals appeared in the very early stages of the ordering, and sometimes already after tempering. Laminated areas with a tetragonal lattice formed parallel to the planes {100} of the cubic matrix. Monoclinic distortions of the matrix as a result of elastic displacement {110} <110> were also observed during aging of alloys of Ni with Be, and of Cu with Be as well as in the ordering of the alloy of Cu with Au. It was concluded that the formation of laminated areas parallel to the crystallographic planes {100} of the matrix, and the monoclinic distortions, are a result of atomic displacements in the directions <110>. G.G.

N65-34700# Joint Publications Research Service, Washington, D. C.
POSSIBILITY OF STRENGTHENING STEEL BY ELECTRON BOMBARDMENT
B. D. Grozin and V. S. Chernenko 22 Sep. 1965 7 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk Uk. RSR (Kiev), No. 2, 1963 p 202–205
(JPRS-32107; TT-65-32600) CFSTI: $1.00

Electron bombardment is shown as a means of hardening steel. Experiments were conducted with steel specimens having a grainy perlite structure and large carbide content which makes high-temperature hardening difficult; the hardness was raised to 900 to 950 kg/mm^2 by electron irradiation. J.M.D.

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N65-33699# American Urethane, Inc., Los Angeles, Calif.
DEVELOPMENT OF CONFIGURATIONS AND COMBINATIONS OF POLYURETHANE FOAM TO PRODUCE MAXIMUM EFFICIENCY IN PACKAGE CUSHIONING MATERIALS Quarterly Progress Report, 1 Feb.–1 Apr. 1965
Samuel M. Goldberg 28 Apr. 1965 17 p
(Contract N600-19-62570)
(AD-465690)

Static data describing the properties of the resilient polyurethane foam materials under investigation was determined in terms of compression load as a function of deflection. An Instron testing machine was used to obtain these results. Data provided a range of load bearing characteristics which allows for the selection of cushioning materials with regard to specific loading requirements. The data were then expanded to demonstrate the wide range of load bearing characteristics that could be designed into each particular type of foam through configuration techniques such as lamination, convolution, die-cutting, and combination. Author

N65-33737# Army Missile Command, Huntsville, Ala. Physical Sciences Lab.
BIAXIAL FRACTURE STRESSES FOR GRAPHITE, CERAMIC, AND FILLED AND REINFORCED EPOXY TUBE SPECIMENS
Richard E. Ely 30 Jun. 1965 42 p refs
(RR-TR-65-10; AD-469036)

Ultimate biaxial stress results are compared with several failure theories for two high density graphites, a steatite, and a filled epoxy-resin. The maximum strain energy theory appeared best for correlating the results if a single theory is used for all stress states. Data given for boron nitride and two grades of glass-cloth, reinforced epoxy resins are meager. All results are for tubular test specimens loaded at room temperature by means of internal fluid pressure and axial loads. Author

N65-33776*# Notre Dame Univ., Ind. Dept. of Chemistry.
FUNDAMENTAL STUDIES ON THE SYNTHESIS OF HEAT-RESISTANT POLYMERS Progress Report No. 4, 1 Feb. 1963–1 Jun. 1964
G. F. D'Alelio 15 Sep. 1964 171 p refs
(Grant NsG-339)
(NASA-CR-64987) CFSTI: HC $4.00/MF $1.00 CSCL 07C

The syntheses of conjugated polymeric Schiff bases and their evaluation as heat resistant polymers was studied. Polymer syntheses by solution and melt processes using dialdehyde and diamine proved deficient because of the reactivity of the aldehyde function, or the amine function, or both functions. Conversion of the aldehyde function, $-CHO$, to other suitable derivatives such as the aldimine function $-CH=NR$, or to the acetal function $-CH-(OR)_2$, and conversion of the amine function, $-NH_2$, to derivatives such as an anil function $-N=CHR$, or to the amide function $-NHOCR$ proved beneficial. The possible nine reaction pairs from these reagents were studied in prototype syntheses of non-polymeric Schiff bases, and then applied to the synthesis of polymers, if applicable. Most of the nine reactions were found broadly applicable in the preparation of aromatic, conjugated, polymeric Schiff bases. Sufficient data were acquired on which to select the better polymerization systems for detailed research. G.G.

N65-33883*# IIT Research Inst., Chicago, Ill.
STABLE WHITE COATINGS Interim Technical Progress Report, Jul. 3, 1964–Mar. 2, 1965
Gene A. Zerlaut, J. E. Gilligan, and Y. Harada 30 Jun. 1965 120 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950746)
(NASA-CR-64948; IITRI-C6027-16) CFSTI: HC $4.00/MF $0.75 CSCL 11B

In a previous research program extensive studies led to the development and specifications of three zinc oxide-pigmented thermal-control coatings. The principal objectives of this program are: improvement of the three paints (as engineering materials); determination of the validity of our accelerated space-simulation testing; and continuation of the zinc oxide photolysis studies begun in the preceding program. Specific tasks that are discussed include: improvement of potassium silicate coatings as engineering materials and elucidation of their storage and handling problems; improvement of methyl silicone coatings as engineering materials; studies of zinc oxide photolysis to establish reasons for the observed stability of zinc oxide; and determination of space-simulation parameters such as long-term stability, effect of coating surface temperature on the rate of degradation, and validity of accelerated testing (by reciprocity and wavelength dependency studies). Author

N65-34121# Dynamic Science Corp., South Pasadena, Calif.
RHEOLOGY OF SILICONE FLUIDS THICKENED WITH BORON NITRIDE Quarterly Report No. 6, 15 Dec. 1963–15 Mar. 1964
15 Mar. 1964 24 p
(Contract AF 33(657)-9155)
(P-51a, QR-6; AD-463719)

The rheological properties of a grease thickened by boron nitride can be improved substantially if the thickener is composed of submicron size particles instead of relatively coarse

grains characteristic of commercial grade material. The submicron material is being prepared by gas phase reaction of ammonia and boron trichloride under high nitrogen dilution at a temperature of 900° C. Purification is being effected by vacuum sublimation of the by-product ammonium chloride. Two boron nitrides have been used to thicken QF-6-7039 fluid, and measurements of consistency as a function of solid/fluid ratio have been carried out. Two or three additional fluids, including MLO-60-231 6 ϕ ether, will also be thickened. Rheological tests will be conducted on all greases at 77° and 600° F, shear rates will range from 2 to 10000 reciprocal seconds. Author

N65-34158# Rock Island Arsenal Lab., Ill. Research and Engineering Div.
DEVELOPMENT OF HEAT SEALABLE COATED FABRICS
Allan C. Saunders Jul. 1965 24 p
(RIA-65-1670; AD-619652)

For many years the Army has experienced problems from moisture which penetrated needle holes left in coated fabrics resulting from sewing. Several coating methods to overcome this problem were used. These added costs and time delays prompted a new look at the development of an improved coated fabric. A research study was initiated wherein 28 varieties of commercially available coated fabrics, 3 substrates (one glass cloth and two varieties of nylon), 8 tie-coatings and 13 polymer coatings were investigated for the purpose of obtaining an improved coated fabric. As a result of these development and evaluation studies, it was found that a dimethyl sulfoxide treatment on an open mesh nylon substrate which was then coated with ethylene/ethyl acrylate produces an acceptable heat sealable all weather coated fabric. The dimethyl sulfoxide pretreated substrate showed an improvement of 20 F in low temperature flexibility over an untreated substrate. Author

N65-34161# California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials.
PHYSICOMECHANICAL BEHAVIOR OF RUBBERLIKE MATERIALS First Annual Report, 1 Feb. 1964–1 Feb. 1965
P. J. Blatz, N. George, and S. Kawabata Apr. 1965 111 p refs
(Contract AF D4(611)-9572)
(MATSCIT-PS-65-2; AFRPL-TR-65-112; AD-619697)

The physicomechanical behavior of gum rubber vulcanizates and concentrates is discussed. A theoretical analysis of failure based upon defect analysis is considered; and thermal effects, and certain electro-mechanical coupling characteristics are evaluated. The work is directed toward understanding the response and failure behavior of composite filled rubbers (e.g. solid propellants) as a function of stress field, deformation field, temperature, time, filler type, filler concentration, plasticizer type, plasticizer concentration, gumstock type, cure density, network topology, and free volume concentration. Equations for the mathematical analyses are worked out. L.S.

N65-34173# Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.
SILICA FIBER/CORE-SHEATH FIBER Final Technical Report, 1 Feb. 1964–1 Jun. 1965
D. Plaskon, D. Bradford, and W. H. Otto 15 Jun. 1965 62 p refs
(Contracts N-600(19)-61810; N-600(19)-59607)
(AD-620055)

This report describes work on a program which called for (1) a study of fused quartz fiber forming from a fluid melt contained in a bushing of tungsten and other materials in an argon atmosphere, and (2) the development of a composite ceramic-glass fiber of core-sheath configuration. *High-Temperature Fiber Forming*—Continuous fused quartz fiber forming was achieved from silica melts contained in both tungsten and yttria-stabilized zirconia bushings operated in an argon atmosphere. Fiber forming temperatures ranged from approximately 1900° C to 2300° C. Fiber tensile strengths approaching 600000 psi were obtained. Bushings were indirectly heated, which permitted flexibility of design and materials. *Core-Sheath Fiber Development*—A systematic study of the crystalline core–vitreous sheath concept was conducted using a double-compartmented platinum alloy bushing in which the inner compartment contained a core material and the outer compartment the sheath material. In addition, a screening program of high-temperature alumina-based glasses was made to investigate oxide compositions other than silica. In general, viscosities were too low and surface tension too high for the standard fiber forming process. Author

N65-34235*# United Aircraft Corp., East Hartford, Conn.
EXPERIMENTAL INVESTIGATION OF THERMAL ANNEALING OF NUCLEAR-REACTOR-INDUCED COLORATION IN FUSED SILICA
F. C. Douglas and R. M. Gagosz Washington, NASA, Sep. 1965 148 p refs
(Contract NASw-768)
(NASA-CR-304) CFSTI: HC $4.00/MF $1.00 CSCL 11B

An experimental investigation was conducted to determine the spectral transmission characteristics of fused silica over a range of temperatures prior to nuclear irradiation and during thermal annealing of reactor-induced coloration following exposure to a dose of 6×10^{17} nvt fast neutrons per cm^2. The preirradiation studies were carried out at a series of fixed temperatures. The annealing studies were carried out using ramp variations of temperature with time and step-wise variations of temperature with time for temperatures between 22° and 1000° C. Most of the annealing data were obtained following step-wise changes in temperature at wavelengths between 0.15 and 4.0 microns. Spectral transmission measurements were also made at wavelengths between 0.15 and 4.0 microns for all samples before nuclear irradiation and after thermal annealing. Test results indicate that nuclear-reactor-induced coloration is greater and more difficult to remove in the ultraviolet portion of the spectrum than in either the visible or the infrared portions of the spectrum. R.W.H.

N65-34322# Sandia Corp., Albuquerque, N. Mex. Mfg. Process Development Div.
SUPERIOR ORGANIC COATINGS
Apr. 1965 10 p refs
(Contract AT(29-1)-789)
(SC-TM-64-995)

A three-process system (surface preparation, primer, and finish coat) is required to obtain a superior organic coating. The processes must be compatible with each other and must be scheduled so that time intervals are correct. Manufacturing steps between these processes must not adversely affect the completed system. A new nondestructive test method, using steam, can indicate coating quality on the finished part before it leaves the factory. Author

N65-34371# Prodesco, Inc., Perkasie, Pa.
WOVEN MESH FROM BRAIDED NYLON CORD Technical Report, 1 Jan.–1 Jul. 1964
H. C. Brockman, J. C. Mc Grath, and J. H. Ross (AF Mater. Lab., Wright-Patterson AFB, Ohio) Wright-Patterson AFB, Ohio, AF Mater. Lab., Apr. 1965 18 p ref
(Contract AF 33(657)-12257)
(AFML-TR-64-413; AD-617930)

The objective of this program was to develop a woven mesh material using MIL-C-5040, type I cord and commercial grade, high tenacity nylon yarn in order to achieve a 1000–1200 lb/in. breaking strength in the warp and filling directions and a geometric porosity of 35%, or a permeability of 800–900 cu ft/sq ft/min. Binder yarns from 30 denier to 200 denier were evaluated in order to achieve the strongest possible bond between warp and filling cords. Various constructions, ranging from 7 ends and picks of cord to 9 ends and picks of cord, were evaluated to achieve the optimum combination of breaking strength and air permeability. Unusual problems were encountered in weaving the cord because of its bulk and stiffness. Considerable yardage would have to be manufactured in order to determine the commercial practicality of the manufacturing technique. This study demonstrated the feasibility of designing and weaving a fabric using a 100 lb breaking strength cord in a crimpless weave for use in special types of parachute applications. Author

N65-34424# Battelle Memorial Inst., Columbus, Ohio.
EFFECTS OF LOW-TEMPERATURE IRRADIATION AND SUBSEQUENT ANNEALING ON THE THERMAL DIFFUSIVITY OF PYROLYTIC CARBON AND PYROLYTIC GRAPHITE
Webster D. Wood, Herbert W. Deem, William H. Goldthwaite 3 Aug. 1965 27 p refs
(Contract W-7405-ENG-92)
(BMI-1739) CFSTI: $0.75

Thermal-diffusivity measurements were made on unirradiated and irradiated pyrolytic graphite and pyrolytic carbon. The annealing of irradiation damage was studied with specimens which had been irradiated with fast neutrons (> 1 Mev) to levels of 2×10^{18}, 2×10^{19}, and 4×10^{20} nvt. Analyses of the activation energies of the annealing process were made on the basis of the thermal-diffusivity measurements and, in general, it was found that the annealing of the irradiation damage for pyrolytic graphite and pyrolytic carbon was the same as for reactor-grade graphite. Author

N65-34462*# California Inst. of Tech., Pasadena. Firestone Flight Sciences Lab.
FAILURE CRITERIA FOR VISCOELASTIC MATERIALS Semiannual Status Report, 1 Jan.–30 Jun. 1965
M. L. Williams and W. G. Knauss Aug. 1965 15 p refs
(Grant NsG-172-60)
(NASA-CR-67159; GALCIT-SM-65-18) CFSTI: HC $1.00/MF $0.50 CSCL 11I

In investigating the various aspects of failure, the following findings were reported: (1) *Specimen Preparation*—Ring specimens cut on a milling machine and measured individually for data reduction purposes were compared with cast specimens. Comparison of failure data from both show essentially the same information. (2) *Monotonic Loading Histories*—Difference in stress–strain behavior for two types of monotonic loading histories was indicated. (3) *Cyclic Loading Histories*—Methods for estimating the temperature rise and the temperature change during testing are discussed. Research in fracture mechanics is summarized, and experiments were begun which consider fracture properties of polymers in the swollen state in an effort to determine the influence of viscoelasticity on the fracture process. R.W.H.

N65-34502*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THERMOPHYSICAL PROPERTIES OF SIX CHARRING ABLATORS FROM 140° TO 700°K AND TWO CHARS FROM 800° TO 3000°K
R. Gale Wilson, comp. Washington, NASA, Oct. 1965 145 p refs
(NASA-TN-D-2991) CFSTI: HC $5.00/MF $1.00 CSCL 11I

Thermophysical property data of the type necessary for the performance analysis and design of entry heat-shields are presented for several ablation materials over the temperature range from −200° to 5000° F (144° to 3030° K). The data include enthalpy, specific heat, thermal conductivity, thermal expansion, density, and tensile and compressive mechanical properties of six ablation materials over the temperature range from −200° to 800° F (144° to 700° K). The enthalpy, specific heat, thermal conductivity, and total normal emittance of the chars formed from thermal degradation of two of the materials are also included. The char properties were measured over the temperature range from 1000° to 5000° F (810° to 3030° K). The materials studied are a high-density phenolic-nylon, a low-density phenolic-nylon, a filled silicone resin, the filled silicone resin in honeycomb, a carbon-fiber-reinforced phenolic, and a low-density filled epoxy in honeycomb. The first four materials were formulated and fabricated at the NASA Langley Research Center. The last two are commercially produced materials—Narmco 4028 and Avcoat 5026-39-HC G. The chars studies were produced from the high- and low-density phenolic-nylon materials. Author

N65-34544# American Cyanamid Co., Stamford, Conn. Central Research Div.
THE RELATIONSHIPS BETWEEN POLYMERS AND GLASS TRANSITION TEMPERATURES Technical Report, Jun. 1963–May 1964
O. Griffin Lewis Wright-Patterson AFB, Ohio, AF Mater. Lab., Jul. 1964 28 p refs
(Contract AF 33(657)-11224)
(ML-TDR-64-253; AD-608925)

The parameter T_0 in the empirical equation

$$\log \eta/d = \log A_\eta + B_\eta/(T-T_0)$$

is being investigated as an indicator of glass formation in simple liquids for which viscosity η and density d have been published at various temperatures T. The parameter B_η was found to equal $T_0 + 350°$ for polystyrene fractions, but this relation does not hold for the n-alkane series. Some correlations have also been discovered between the above constants and those in the Antoine equation for vapor pressure of the same liquid. It was found that the Gibbs-DiMarzio theory correctly predicts the values of T_0 of the n-alkanes with a stiffness energy of 490 cal./mole. The predicted T_0 for polyethylene is 129° K, which corresponds to a well-known transition. A detailed study of steric factors in polymers is expected to lead to methods of predicting the stiffness energy and hence T_0. A free volume theory has been developed which accounts satisfactorily for the change in viscosity with external pressure, and which separates the phenomenological effects of temperature and pressure from the structural and molecular factors involved in flow behavior. Author

N65-34556# California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials.
A CROSS-LINKED POLYMER STANDARD REPORT ON POLYMER SELECTION First Annual Report 1, Feb. 1964–1 Feb. 1965
W. G. Knauss Apr. 1965 61 p refs
(Contract AF 04(611)-9572)
(MATSCIT-PS-65-3; AFRPL-TR-65-111; AD-619698)

Solithane 113 was selected from a list of six cross-linked polymers for a possible solid rocket propellant standard, and the reproducibility of its properties was investigated. Six sheet

specimens with a polymer content of 43 to 60 percent were measured for: (1) shear modules as determined with the torsion pendulum; (2) strain-optic coefficient at a constant tensile strain rate; (3) uniaxial tensile strength at a constant tensile strain rate; and (4) volume increase in benzene. Results indicated that an increase in polymer content resulted in an increase of the rubbery modulus, as well as in raising of the glass transition temperature. Cure parameter studies found that the mechanical properties are not as sensitive to variations in cure time and cure temperature, as to variations in the catalyst-polymer composition. Uncontrollable variations in cure time and cure temperature can be minimized by selecting appropriate values for them. G.G.

N65-34564# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Mechanics.
PHYSICAL MODEL OF A 6-CONSTANT ANISOTROPIC ELASTIC MATERIAL
W. H. Hoppmann, II and V. X. Kunukkasseril Jul. 1965 26 p refs
(Contract DA-30-069-AMC-589(R))
(AD-619914)

The physical model of a multi-constant elastic material with consideration of couple-stresses, is studied critically to determine whether it more reasonably represents a 3-constant isotropic material or a 6-constant centro-symmetric cubic crystalline material. A description of a critical shear experiment on the model is presented along with experimental results. A parameter α which is definitively related to the question is defined and its value determined on the basis of statical deformation experiments. The conclusion is that the model behaves as a cubic crystal showing couple-stress effects. Author

N65-34590* Martin Co., Baltimore, Md.
RADIATION-INDUCED ELECTRICAL PROPERTY CHANGES IN POLYMERIC SOLIDS
S. E. Harrison and E. A. Szymkowiak *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 131–136 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Radiation-induced changes in the dissipation factor and conductivity as a function of dose and dose rate are discussed, and the changes are related to the mechanism of damage. In the dissipation studies, experiments were conducted on tetrafluorethylene materials, and the radiation source used was a 50 kVp continuous duty X-ray machine. It was shown that the dissipation factor changes by orders of magnitude as a function of dose, and that these changes are dependent upon temperature, pressure, ambient gas composition, and dose rate. The time-dependent behavior characteristics of induced conductivity in organic insulating solids, when exposed to high intensity, short behavior duration ionizing radiation, were broken down into three time intervals, and expressions were derived for the relationships. It was concluded that conductivity is particularly sensitive to dose rate, and that the decay of photon-induced conductivity changes is controlled by a trapping process. Graphs illustrate the data. M.G.J.

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N65-33739# Rohm and Haas Co., Huntsville, Ala. Redstone Arsenal Research Div.
THE MULTIDATA METHOD OF APPROXIMATE LAPLACE TRANSFORM INVERSION Special Report
Thomas L. Cost and Eric B. Becker 7 Sep. 1965 50 p refs
(Contract DA-01-021-AMC-11536(Z))
(S-51; AD-469227)

A newly developed approximate Laplace transform inversion method is described. A derivation of the method, termed the "multidata method" is presented along with a derivation of Schapery's collocation method. Similarities and differences between the two methods are described and discussed. Results of parameter studies of both methods are presented which demonstrate the sensitivity of error displayed by the collocation method and the improved accuracy obtainable with the multidata method as compared with the collocation method when errors exist in the function to be inverted. Computer program listings and operating instructions for both methods are presented. Author

N65-33768# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
ON SOME SELECTION AND RANKING PROCEDURES FOR MULTIVARIATE NORMAL POPULATIONS USING DISTANCE FUNCTIONS
Shanti S. Gupta Jun. 1965 35 p refs *Its* Mimeograph Ser. No. 43
(Contract AF 33(657)-11737)
(AD-618524)

The selection problem for the $k(k \geq 2)$ non-central chi-square populations was studied to find selected populations with large values of the parameters λ_i, selecting as far as possible the best ones. Defined is a probability procedure where the probability is at least equal to a given number P^* $(1/k < P^* < 1)$, and where the population with the largest value is included in the selected subset. The size of the subset is an integer-valued random variable which takes values 1,2, ...,k. The loss connected with the selection and non-selection of the population with the largest value, and the risk, is bounded so that the least upper bound of this risk is $\leq 1-P^*$. G.G.

N65-33769# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
AN ALTERNATIVE PROOF OF A THEOREM OF TAKACS ON THE GI(M)1 QUEUE
Marcel F. Neuts Jun. 1965 8 p refs *Its* Mimeograph Ser. No. 47
(Contract Nonr-1100(26))
(AD-618530)

An analytic proof is given of the fact that the stationary distribution for the imbedded Markov chain in a $GI|M|1$ queue is geometric. A generating function for the stationary transition probabilities is obtained as the unique solution to an integro-differential equation, which may be solved by reduction to a Wiener–Hopf equation. We assume that customers arrive at a counter at the instants $\tau_0, \tau_1, \ldots$ and that the interarrival times $\tau_{n+1} - \tau_n$, $(n = 0,1,\ldots)$ are independent, identically distributed, positive random variables with distribution function $F(x)$. The service times are independent, identically distributed, negative exponential random variables with parameter μ. Author

N65-33781# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
RECENT ADI THEORY AND RESULTS FOR ELLIPTIC EQUATIONS
E. L. Wachspress Feb. 1965 8 p refs Presented at the IFIP Congr., New York, 24–29 May 1965
(Contract W-31-109-ENG-52)
(Conf-650505-2)

Several recent alternating-direction-implicit (ADI) theories and numerical results are discussed, and an iterative procedure for elliptic systems using the ADI model-problem deviation factor is presented. G.G.

N65-33789# Harvard Univ., Cambridge, Mass. Cruft Lab.
EXPERIMENTS WITH A PATTERN CLASSIFICATION TECHNIQUE
Y. C. Ho, A. Arcese (Honeywell, Inc.), R. L. Kashyap, and C. Blaydon 21 May 1965 39 p refs
(Contract Nonr-1866(16))
(TR-472; AD-465187)

A variety of problems in different fields of engineering can be formulated as problems of pattern classification. A set of pattern vectors, x, belonging both to class A and class B are given. It is required to find the function f (x) such that f 0 when x A and f < 0 when x B. An exponentially convergent and finite iterative procedure for solution of this problem fo. linear f is presented. The statistical and geometrical properties of the procedure as well as methods for extension to nonlinear cases are discussed. The procedure is applied to the design of: (1) switching circuits which are linearly or quadratically separable; (2) filters for two-dimensional picture processing involving the detection of tanks in backgrounds; (3) optimal feedback controller for linear dynamic systems. Results of the experiments (1-3) confirm the potential and utility of the procedure. Author

N65-34056# California Univ., Berkeley. Operations Research Center.
ON SIMPLE FINITE CAPACITY DAMS AND QUEUES
Geoffrey F. Yeo 13 Aug. 1964 18 p refs
(Grant NSF GP-2633)
Geoffrey F. Yeo 13 Aug. 1964 18 p refs
(ORC-64-19; AD-615175)

Various properties of two mathematical models concerned with the theory of dams and queues are discussed. In the first example a dam of finite capacity fed by inputs, where the size of each is a random variable having a negative exponential distribution with mean μ^{-1}, which occurs in a time-homogeneous Poisson process with a parameter of $\lambda(0 < \lambda < \infty)$ is considered. The release of water is continued at unit rate per unit time unless the dam is empty, and any part of an input which raises the total content overflows and is lost. In the second example it is assumed that customers arrive at a counter with a single server in a time-homogeneous Poisson process with parameter $\lambda(0 < \lambda < \infty)$. Customers (who are served on a first-come first-served queue discipline) have independently and identically distributed negative exponential service times with mean μ^{-1}. Deterministic customer impatience is assumed, so that if a customer arrives to find that he has a wait exceeding b before commencing service, he departs forever from the system without being served. Solutions to equations for the models are shown. L.S.

N65-34058# Wisconsin Univ., Madison. Mathematics Research Center.
INDEFINITE INTEGRATION BY RESIDUES, II
R. P. Boas, Jr. (Northwestern Univ.) and Lowell Schoenfeld (Penn. State Univ.) Feb. 1965 18 p refs
(Contract DA-11-022-ORD-2059)
(MRC-TSR-542; AD-614810)

The principal results of this paper may be stated as follows. Let F(z) be holomorphic in the extended complex plane except for a finite number of singularities, let F(z) be holomorphic on the open arc $(e^{i\alpha} \ldots e^{i\beta})$ of the unit circle except for simple poles, and let F(z) be holomorphic at $e^{i\alpha}$ and at $e^{i\beta}$. If $\alpha < \beta < \alpha + 2\pi$ and $\mu = (\beta - \alpha)/2$ then the Cauchy principal value integral ${}_{\alpha}\int^{\beta} F(e^{i\vartheta})d\vartheta = i(R + r)$ where R = sum of the residues of $\frac{F(z)}{z} \log\left(e^{i\mu}\frac{z-e^{i\alpha}}{z-e^{i\beta}}\right)$ for z in the extended plane but not on the closed arc $[e^{i\alpha} \ldots e^{i\beta}]$

$$r = \text{sum of the residues of } \frac{F(z)}{z}\log\left(e^{i\mu}\frac{z-e^{i\alpha}}{e^{i\beta}-z}\right) \text{ for } z \text{ on } (e^{i\alpha} \ldots e^{i\beta}).$$

This corrects and extends a result of R. P. Boas, Jr., Amer. Math. Monthly 71(1964)298-300. The proof depends on the substitution

$z = \{\sin(\vartheta - \alpha)/2\}/\sin(\beta - \vartheta)/2$ which gives P. V. ${}_{\alpha}\int_{\beta} F(e^{i\vartheta})d\vartheta$ p.V. ${}_{0}\int^{\infty} F_1(z)dz$ where

$$F_1(z) = \frac{2\sin\mu}{(z+e^{i\mu})(z+e^{-i\mu})} F\left(e^{i\beta}\frac{z+e^{-i\mu}}{z+e^{i\mu}}\right)$$

Standard techniques are now applied to P.V. ${}_{0}\int^{\infty} F_1(z)dz$ to yield the result stated. Author

N65-34059# Wisconsin Univ., Madison. Mathematics Research Center.
UPON A GENERAL SYSTEM OF ORTHOGONAL POLYNOMIALS
P. Wynn Mar. 1965 25 p refs
(Contract DA-11-022-ORD-2059)
(MRC-TSR-548; AD-614811)

The power series $\sum_{s=0}^{\infty} c_{m+s}z^{-s-1}$ may be transformed into its corresponding and associated continued fractions with the help of the q-d algorithm: the system of polynomials $p_n^{(m)}(z)$ which is orthogonal with respect to the sequence of weights $\{c_{m+s}\}$ may be constructed by solving the sets on linear equatio) which may be derived from the conditions of orthogonality. Both processes are formally equivalent, but the first is easier to carry out. It is shown firstly that if

$$c_0 = 1,\ c_m = \frac{(A-q^{\alpha})(A-q^{\alpha+1})\ldots(A-q^{\alpha+m-1})}{(C-q^{\gamma})(C-q^{\gamma+1})\ldots(C-q^{\gamma+m-1})}\ (m = 0.1\ldots)$$

then the corresponding and associated continued fractions have coefficients which may be expressed in a simple closed form, and secondly that the orthogonal polynomials derived from this sequence of weights also have coefficients which may be expressed in simple closed form. Special choices of the parameters q, A, α, C and γ lead in turn to the derivation of the Jacobi, Gegenbauer, Legendre, Tschebyscheff, Laguerre, Hermite and Bessel polynomials. Further choices of these parameters lead to entirely new systems of orthogonal polynomials. Author

N65-34060# Wisconsin Univ., Madison. Mathematics Research Center.
STRUCTURAL PROBABILITY AND A GENERALIZATION
D. A. S. Fraser (Toronto Univ.) Mar. 1965 19 p refs
(Contract DA-11-022-ORD-2059)
(MRC-TSR-556; AD-614812)

Structural probability, a reformulation of fiducial probability for transformation models, is discussed in terms of an error variable. A consistency condition is established concerning

conditional distributions on the parameter space; this supplements the consistency under Bayesian manipulations found in Fraser (1961). An extension of structural probability for real-parameter models is developed; it provides an alternative to the local analysis in Fraser (1964b). Author

N65-34062# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
SELECTION AND RANKING PROCEDURES AND ORDER STATISTICS FOR THE BINOMIAL DISTRIBUTION
Shanti S. Gupta Oct. 1964 17 p refs Prepared in cooperation with Stanford Univ. *Its* Mimeograph Ser. No. 31
(Contracts AF 33(657)-11737; Nonr-225(53))
(AD-614070)

The first part of this paper describes some work on selection and ranking procedures for binomial populations. The procedures discussed here fall in the following two categories (1) procedures for selecting a subset containing the best population or all those populations that are better than a standard (2) procedures for selecting the best. The second part of this paper discusses order statistics from the binomial distribution and describes some new tables of moments and cumulative distribution function of these order statistics. Author

N65-34117# Stanford Univ., Calif. Applied Mathematics and Statistics Labs.
IRRATIONAL FRACTION APPROXIMATIONS TO MILL'S RATIO
Harold Ruben 31 Jul. 1963 15 p refs
(Contract Nonr-225(52))
(TR-89; AD-617939)

Mill's ratio for the normal probability integral [R(x)] was expanded in terms of irrational fractions; the expansion is asymptotic and convergent for all values of $x > 0$. For high or moderate positive values of x, the expansion converges very rapidly to R(x); numerical examination suggests that the convergence is more rapid than in Shenton's sequence of approximations. Derivation of the expansion is detailed and its accuracy is evaluated. A table presents accuracy of approximations to R(x); numerical error in the Nth order Shenton and the Nth order present approximations to R(x) are given for values 1, 2, 3, 4, 5, and 6; numerical errors are also given when Boyd's lower and upper bounds are used as approximations for R(x). The proposed approximations are superior to those of Shenton when $x \geq 4$; the reverse is the case for the lower values of x. M.W.R.

N65-34130# Michigan Univ., Ann Arbor. Radiation Lab.
TABLES OF PROLATE SPHEROIDAL FUNCTIONS FOR M = 0, VOLUME I: SCIENTIFIC REPORT NO. 1
H. E. Hunter, D. B. Kirk, T. B. A. Senior, and E. R. Wittenberg Apr. 1965 296 p *Its* Rept.-07133-1-T
(Contract AF 19(628)-4328)
(AFCRL-65-283(I); AD-619979)

The eigenvalues $\lambda_{on}(c)$ and normalization constants $N_{on}(c)$ are tabulated for $c = 0.1(0.1)10.0$ and n ranging from 0 up to a maximum of 20. The radial functions of the first and second kinds, and their first derivatives, are given for the same c and n for $\xi = 1.0000500$, 1.0050378, 1.0206207 and 1.1547005, corresponding to prolate spheroids of length-to-width ratios 100:1, 10:1, 5:1 and 2:1 respectively. Values of the angular functions are contained in a companion report (7133-2-T). All computations were carried out on The University of Michigan IBM 7090 computer. The program, which can also be used for the determination of the functions of orders 1 and 2, is described in some detail. Author

N65-34131# Michigan Univ., Ann Arbor. Radiation Lab.
TABLES OF PROLATE SPHEROIDAL FUNCTIONS FOR M = 0, VOLUME II Scientific Report No. 1
H. E. Hunter, D. B. Kirk, T. B. A. Senior, and E. R. Wittenberg Apr. 1965 354 p ref *Its* Rept.-07133-2-T
(Contract AF 19(628)-4328)
(AFCRL-65-283(II); AD-619980)

The angular prolate spheroidal functions $S_{mn}(c,\eta)$ and $S_{on}(c,\eta)$ are tabulated for $c = 0.1(0.1)10.0$, n ranging from 0 up to a maximum of 20, and $\eta = 0(0.05)1.0$. Corresponding values of the eigenvalues, normalization constants and radial functions were given in the preceding report. Author

N65-34175# New York Univ., N. Y. Courant Inst. of Mathematical Sciences.
ASYMPTOTIC SOLUTION OF A DISPERSIVE HYPERBOLIC EQUATION WITH VARIABLE COEFFICIENTS
Norman Bleistein and Robert M. Lewis Jun. 1965 79 p refs
(Contract AF 19(628)-4065)
(EMP-206; AFCRL-65-455; AD-619956)

Considered are the initial-boundary value problems for an energy conserving dispersive hyperbolic equation, the Klein-Gordon equation. This equation contains the main feature of dispersion: the speed of propagation depends on the frequency. The primary purpose of this paper is to compare the asymptotic expansion of solutions obtained by a technique, which the authors call the ray method, with the asymptotic expansion of the exact solution. In every case considered, the solutions agree. Solutions are obtained for a series of initial-boundary value problems in one space dimension with variable coefficients. A new feature called space-time diffraction was found. This phenomenon has the following physical interpretation: a portion of the energy of a wave reaches a boundary surface and then gradually leaks off, leaving a diminishing residue on the boundary for all time. Author

N65-34207# Stanford Univ., Calif. Dept. of Computer Science
AN ANALYSIS OF ONE ALGORITHM OF HEIGHTENED PRECISION OF THE METHOD OF NETS FOR THE SOLUTION OF POISSON'S EQUATION
E. A. Volkov 4 Jul. 1965 31 p refs Transl. into ENGLISH from Vychislitel'naya Mat. (USSR), v. 1, 1957 p 62–80
(Contract Nonr-225(37))
(CS27; AD-618216)

In this work, we investigate a technique of successive improvement for the finite-difference solution of Poisson's equation, proposed empirically in a work by L. Fox. The basic results were explained. Author

N65-34256# Stanford Univ., Calif. Dept. of Statistics.
THE ROLE OF SPECTRAL ANALYSIS IN TIME SERIES ANALYSIS
Emanuel Parzen 12 Jul. 1965 27 p refs Presented at Inter. Statist. Inst., Sep. 1965
(Contract Nonr-225(80))
(TR-2; AD-617937)

Our aim in this paper is (1) to summarize the basic formulas employed in the empirical spectral analysis of a single time series, and (2) to show their applicability to the problem of analyzing and synthesizing "adaptive predictors" for time series. Author

N65-34359# College of Aeronautics, Cranfield (England)
STABILITY OF THE PERIODIC SOLUTIONS TO DUFFING'S EQUATION AND OTHER NONLINEAR EQUATIONS OF SECOND-ORDER

P. A. T. Christopher Mar. 1965 24 p refs
(CoA-Aero-180) CFSTI: HC $1.00/MF $0.50

The stability of the periodic solutions of Duffing's equation is discussed in terms of the asymptotic stability of the corresponding "variational equation" and, thereby, in terms of the characteristic exponents of this equation. Two methods of evaluating the characteristic exponents are considered. The first is based on Whittaker's form of solution of Mathieu's equation and the second, due to Hale, is based on a general iterative method for determining periodic solutions of systems possessing a small parameter. The methods are compared and it is shown that the results for the two methods are in agreement. Author

N65-34432*# Martin Co., Denver, Colo.
ON THE OPTIMALITY OF A TOTALLY SINGULAR VECTOR CONTROL: AN EXTENSION OF THE GREEN'S THEOREM APPROACH TO HIGHER DIMENSIONS
George W. Haynes Washington, NASA, Sep. 1965 29 p refs
(Contract NAS2-2351)
(NASA-CR-305) CFSTI: HC $2.00/MF $0.50 CSCL 12A

An extension of the Green's theorem approach to higher dimensions has been derived for the determination of the optimality of totally singular vector controls governing n dimensional nonlinear systems with the (n-1) dimensional vector control appearing linearly. The essential condition that motivates the analysis is that the coefficients of the vector control, when viewed as tangent vectors, form a complete system of partial differential equations of order (n-1). Author

N65-34519# Wisconsin Univ., Madison. Dept. of Mathematics.
UNIFORMISATION OF A QUASILINEAR HYPERBOLIC EQUATION. PART I: THE FORMAL SOLUTION
R. E. Meyer [1965] 47 p refs
(Contract Nonr-1202(27))
(TR-1202(27)/1; AD-469972)

The Cauchy and characteristic boundary value problems for a typical system (Section 3) of homogeneous differential equations in two independent and two dependent variables are studied and a generalised 'formal' solution is established which (i) exists on the maximal domain of uniqueness and (ii) is identical with the classical solution where that exists uniquely. The formal solution removes the obstacle which the limitations of the classical existence theorem put in the way of a study of the solution structure. It is hoped that the understanding thus opened up will advance the study of the solutions of n conservation laws for n > 1. Author

N65-34531# Maryland Univ., College Park.
FUNDAMENTAL RESEARCH IN APPLIED MATHEMATICS Final Report, 1 Jul. 1964–30 Jun. 1965
M. H. Martin and W. Rheinboldt Jul. 1965 13 p refs
(Grant DA-ARO(D)-31-124-G-563)
(AROD-407-68; AD-619461)

Work is reported on the following problems: (1) Solution of partial differential inequalities to yield uniqueness in a study of periodic waves of finite amplitude in an irrotational motion; (2) generalization of the concept of comparison-factor for linear approximation problems, and different concepts of iterative solutions of non-linear operator equations; (3) partial differential equations for solutions of problems for linear hyperbolic operators; and (4) studies of the analytical properties and singularities of the scattering amplitude in the quantum theory of interacting particles and fields, and of the equations and motions of particles and fields in quantum theory. G.G.

N65-34535# Measurement Analysis Corp., Los Angeles, Calif.
MEASUREMENT OF MATRIX FREQUENCY RESPONSE FUNCTIONS AND MULTIPLE COHERENCE FUNCTIONS
N. R. Goodman Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Jun. 1965 34 p refs
(Contract AF 33(615)-1418)
(MAC-403-08; AFFDL-TR-65-56; AD-619993)

The report describes fundamental concepts involved in the statistical analysis of multiple-input single-output time-invariant linear systems. The definitions of a matrix frequency response function and a multiple coherence function are presented. Also discussed are marginal and conditional (partial) coherence functions with emphasis on their interpretation. Formulas for computing simultaneous confidence bands for all elements of the matrix frequency response function are presented. The interpretation of linear system computational results in terms of a time invariant nonlinear system model is described. It is shown how the linear system results provide what may be thought of as a "best" linear fit to the nonlinear model. The multiple coherence function then gives a quantitative measure of goodness of this fit. In this sense the coherence function may be used to provide a test for system linearity. Author

N65-34558# California Univ., Berkeley. Operations Research Center.
SOME EXTENSIONS OF A CYCLIC QUEUE THEORY
Richard J. Swersey Jun. 1965 28 p refs
(Contract Nonr-222(83); Grant NSF GP-4593)
(ORC-65-14; AD-619874)

The theory of series cyclic queues is generalized to other configurations such as branching series queueing models. An equivalence relation is developed between time average steady state probabilities and the stationary probabilities of the imbedded Markov Chain of a series cyclic queue. A statistical inference model is developed to estimate the mean exponential service rate for a series cyclic queue model. Author

N65-34559# California Univ., Berkeley. Operations Research Center.
STOCHASTIC WEAR PROCESSES
Richard Morey Jun. 1965 37 p refs
(Contract Nonr-3656(18))
(ORC-65-16; AD-619875)

A new class of non-decreasing stochastic processes is characterized. These processes satisfy a generalization of the motion of an increasing failure rate. From physical considerations, these processes seem suitable for describing the process of cumulative wear or damage. The main interest with the model is an investigation of the first time until the process exceeds a random barrier. For this class of processes, it is shown that the first passage time random variable across a random barrier has an increasing failure rate, regardless of the distribution of the barrier. In addition, by the use of certain intuitive, non-parametric assumptions, tight bounds on the moments of this first passage time random variable are obtained. Author

N65-34560# Case Inst. of Tech., Cleveland, Ohio.
FUNCTION THEORY ON ALGEBRAS Final Report, 1 Sep. 1964–31 Aug. 1965
R. F. Rinehart 31 Aug. 1965 9 p
(Grant DA-ARO(D)-D-31-124-G-601)
(AROD-5006-3; AD-617737)

The differentials of primary functions and the function theoretic nature of $dg(\lambda_1,\ldots,\lambda_n) = D$, and of P in $P^{-1}XP = dg(\lambda_1, \lambda_2,\ldots,\lambda_n)$ as functions of X on the open set of n x n

matrices with distinct eigenvalues were examined. The following results have been obtained for X in the open set K of matrices with distinct eigenvalues: (1) The Hausdorff derivative of D is equal to I throughout K; (2) the Hausdorff derivative of P, for appropriate choice of P, is identically zero throughout K; (3) each eigenvalue λ_j of $X \epsilon$ K, regarded as a function of the elements of X, satisfies the universal partial differential equation

$$\sum_i^n = 1 \frac{\partial \lambda_j}{\partial x_{ii}} = 1;$$

and (4) for M_R^n the set of all real n x n matrices, choosing the columns of P to be vectors of unit length, automatically yields a Hausdorff-differentiable P on the subset of real matrices with distinct eigenvalues, and P has the property (2) above. G.G.

N65-34562# California Univ., Berkeley. Operations Research Center.
RELIABILITY ESTIMATION UNDER PLAUSIBLE ASSUMPTIONS
Frank Proschan May 1965 26 p refs Presented at the Meeting of the Intern. Statist. Inst., Belgrade, 14–22 Sep. 1965
(Contract Nonr-3656(18))
(ORC-65-13; AD-619873)

An expository survey of research in reliability estimation based on assumptions made not for mathematical convenience but because they correspond to the physical situation is presented. Summarized is the research concerning the errors resulting from using standard exponential life test and estimation procedures when the distribution has an increasing or decreasing failure rate. The estimation of an evolving reliability, based on observations obtained at successive stages of evolution, is discussed. The monotonicity of reliability in succeeding stages is assumed, and maximum likelihood estimators and conservative confidence bounds are obtained for parameters or functions arising in reliability growth problems. R.W.H.

N65-34696# Boeing Scientific Research Labs., Seattle, Wash.
PROGRAMMING UNDER UNCERTAINTY AND STOCHASTIC OPTIMAL CONTROL
Richard Van Slyke and Roger Wets Apr. 1965 32 p refs *Its* Math. Note No. 405
(Contract Nonr-222(83))
(DI-82-0429; AD-618201)

This paper extends the theory of Programing under Uncertainty to the case when the decision variables are elements of a Banach space. This approach leads to a very natural application of the computational techniques of mathematical programing to stochastic optimal control problems. It is shown that there exists an equivalent deterministic mathematical program whose set of feasible solutions is a convex set and whose objective function can be expressed as a convex function of the initial decision variables. In the second part, a duality theory is developed for this class of problems and some of the relations to the maximum principle for stochastic linear control problems are given. Author

N65-34719# California Univ., Berkeley. Dept. of Mathematics.
ADIABATIC INVARIANCE IV: NOTE ON A NEW METHOD FOR LORENTZ'S PENDULUM PROBLEM
J. E. Littlewood Jun. 1965 11 p ref
(Contract Nonr 22(60))
(AD-618747)

The present paper considers the two-dimensional motion of a unit mass acted on by a force $\omega^{-1}r^{-2}$ where ω is a slowly varying function of time. The eccentricity of the instantaneous ellipse is found to be an adiabatic invariant such that $e^2(-\infty)-e^2(\infty) = O(\epsilon^n)$ for all n where ϵ is an appropriate measure of slowness of the variation of ω over all time. There is some similarity between this result and Kruskal's consideration of a charged particle in a slowly varying magnetic field. Author

N65-34720# California Univ., Berkeley. Dept. of Mathematics.
ADIABATIC INVARIANCE III: THE EQUATION $\ddot{X} = -V_x(X, \Omega)$
J. E. Littlewood Jun. 1965 22 p
(Contract Nonr-222(00))
(AD-618746)

The equation $\ddot{X} = -V_x(X,\omega)$ is considered where $V_x = \partial V/\partial X$, and ω varies slowly with t in $-\infty < t < \infty$. If ω is fixed at $\omega_\tau = \omega(\tau)$, a modified equation results. From this it is shown that a periodic motion is present. Associated with this momentary periodic motion at time τ there is an adiabatic invariant. It is proven that this invariant is approximately constant in $-\infty < t < \infty$. C.T.C

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics and 30 Space Sciences.

N65-33618* National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.
MODELS FOR OBTAINING EFFECTS OF GROUND WINDS ON SPACE VEHICLES ERECTED ON THE LAUNCH PAD
Wilmer H. Reed, III *In* Va. Polytech. Inst. The Role of Simulation in Space Technol., Pt. C [1964] 56 p refs (See N65-33611 22-30) CFSTI: HC $6.00/MF $1.50

The paper describes how, through simulation with physical and mathematical models, the effects of ground winds on erected launch vehicles are being studied at the NASA, Langley Research Center. Experimental programs include both aeroelastically scaled models in wind tunnels and full-scale vehicles in natural winds. With the aid of a mathematical model having nonlinear aerodynamic damping, insight is gained which helps explain why in some instances the response at supercritical Reynolds numbers is a result of random forced excitation while in other instances is characterized by a self-excited periodic motion. Consideration is also given to the response of erected vehicles to atmospheric turbulence. It is shown that at the fundamental cantilever frequency of Saturn V class vehicles the gust velocities along the vehicle are essentially uncorrelated for separation distances greater than a few vehicle diameters. Calculations indicate that the response is significantly reduced when these spatial correlations of gusts are taken into account. Auth

N65-33644 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
CHAFF AS A WIND SENSOR
B. T. Miers *In* Inter-Range Instrumentation Group Meteor. Rocket Network Feb. 1965 p 253–258 (See N65-33622-31)

Cylindrical dipole chaff was evaluated for its performance characteristics as a sensor. Fall velocity data for 0.01 inch copper chaff, 0.005 inch copper chaff, and 0.0035 inch nylon chaff exhibited a wide range of variations; 0.01 inch copper chaff had optimum fall velocities between 15 and 35 km. A

0.005 inch copper chaff was found most useful between 30 and 55 km, and the small nylon chaff was most useful above 55 km heights. A number of radar signal strength recordings during chaff tracking operations established that signal strength is a function of dispersion, which in turn is a function of time, wind structure, and slant range. Comparisons of high altitude wind measurements derived from parachutes, spheres, and chaff showed the largest differences occurring in the north–south components at very light wind speeds. It was concluded that the response of optimized chaff provides wind data to 80 kilometers altitude with reasonable accuracy. G.G.

N65-33648 Pan American World Airways, Inc., Patrick AFB, Fla.
A METHOD FOR COMPUTING BALLISTIC WIND DATA FOR APPLICATION TO ARCAS LAUNCHER SETTINGS
O. H. Daniel *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 301–306 (See N65-33632 22-31)

A manual technique for computing ballistic winds and Arcas launcher settings is discussed, along with the description of a method using an electric computer. Detailed wind structures to an altitude of at least 2000 feet were measured by triple theodolite network and manually reduced on a double theodolite plotting board. The remaining 20% of the weighted ballistic wind were obtained from rawinsonde observations of the layer from 2000 to 48000 feet. The total ballistic zone was then divided into five equally weighted layers, and the ballistic winds for the cross range and down range planes for each of the zones were calculated and corrected for the tower tilt used in the Arcas launch. Reduction of the triple theodolite wind data and of the rawinsonde observations by digital computer provided additional automatic input data to the ballistics wind program. Cross range and down range components of the ballistic wind were computed, and the final launcher setting was expressed as a tower tilt from the zenith. G.G.

N65-33649 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
METEOROLOGICAL ROCKET NETWORK DATA REDUCTION
J. E. Morris *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 307–312 (See N65-33632 22-31)

Collection, reduction, and dissemination of meteorological data from a diversity of instrumentation used throughout the participating network stations is described. Raw wind data were received in the form of an X, Y, Z plot of the radar track of the passive wind sensor used, and the standard X, Y scale factor of 4000 yards per inch was applied whenever feasible. A graphical reduction technique which employs plastic overlays was used to determine the speed and direction of the wind, and all wind data were reduced according to time intervals. Data were then punched on IBM cards for printouts. A sample graphical presentation of computed wind and temperature data developed from temperature, altitude, and pressure values near the top of a radiosonde, are shown. G.G.

N65-33743# Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex. Meteorological Support Div.
ATHENA FLIGHT NUMBER 019 Meteorological Data Report, 31 Jul. 1965
Harold M. Richart Aug. 1965 57 p refs
(ERDA-336; AD-468709)

Meteorological data gathered for the launching of Athena Flight Number 019, Vehicle #D-004 are presented for the Air Force Ballistic Missile Re-entry Systems Office and for ballistic studies. The data are presented in tabular form. Author

N65-33793# Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex. Meteorological Support Div.
AEROBEE NA 3.163 (S/N NRL 106) (21 JANUARY 1965) Meteorological Data Report
Marjorie Mc Lardie Hoidale Feb. 1965 47 p refs
(ERDA-266)

Meteorological data gathered for the launching of Aerobee are presented for the U. S. Naval Research Laboratory and for ballistic studies. The data appear, along with calculated ballistic data, in Appendixes A, B, C, and D. Author

N65-33931# Wisconsin Univ., Madison. Dept. of Meteorology.
STUDIES IN ATMOSPHERIC ENERGETICS BASED ON AERO-SPACE PROBINGS Annual Report on Research, 1963–1964
V. E. Suomi et al 1 Oct. 1964 76 p refs
(Grant WBG-10)

Numerous radiosonde studies of atmospheric clouds are reported briefly. Those reported in greater detail concern the effects of a thin cloud layer, detectable neither from above nor below, on measurement of outgoing flux and surface temperature; use of net radiometersonde to measure the daytime infrared and downward short-wave radio radiation in the absence of clouds and for sun elevation angles greater than fifty degrees; a radiative transfer model incorporating variable cloud blackness to obtain infrared fluxes through an atmosphere with clouds; and radiometric measurements of the effective long-wave emissivity of clouds obtained through thermal energy relations at cloud tops and bases. J.M.D.

N65-33942# Meteorology International, Inc., Monterey, Calif.
EVALUATION OF THE DIAGNOSTIC-CYCLE ROUTINE IN THE INTERPRETATION OF LAYER-CLOUD EVOLUTIONS Final Report
Roland E. Nagle, James R. Clark, and Manfred M. Holl 15 May 1965 98 p refs
(Contract Cwb-10884)

A collection of objectively-formulated, computer-programed techniques, called the Diagnostic-Cycle Routine, designed for assimilating, inter-comparing, and interpreting interrelated meteorological observations (including satellite videographs) is evaluated. From the inferred evolution of the mass-structure distribution of cloudiness, the horizontal velocity distribution for one or more isentropic surfaces is diagnosed. The Routine is used to derive net horizontal and net vertical, parcel-displacements for layer-cloudiness for specified regions and periods of time, by using the horizontal velocity distribution as input. Pattern configurations of layer-cloudiness are then remapped to later positions which are consistent with the concomitant mass-motion evolution. The layer-cloudiness distributions for the initial and terminal times of five separate cases, were analyzed, and mapped in accordance with the net horizontal displacement field. The implications of the cloud data are discussed, and the maps are depicted. L.S.

N65-34186# Army Electronics Labs., Fort Monmouth, N. J. Meteorological Div.
EFFECTIVE CLEAR SKY TEMPERATURES IN THE 8- TO 14-MICRON BAND
Albert R. Tebo May 1965 57 p refs
(ECOM-2592; AD-619456)

Apparent sky temperatures were measured on clear days and nights during a period in July and August of 1964 at Flagstaff, Arizona. A portable radiometer, with a two-degree field

of view, sensing in the wavelength band 8 to 14 microns, was used to read sky temperatures at 5-degree intervals of zenith distances (angles) from the zenith to the horizon. These values were converted to radiances and summed over the whole sky, to arrive at effective whole-sky temperatures. The apparent sky temperature at any zenith distance is not dependent on azimuth, but does vary with the time of day. The elevation scan of temperatures at a given time is duplicated by that of an equally clear sky at a different time if the zenith temperatures are the same. The effective whole-sky temperature is consistently the same value as the apparent sky temperature at a zenith distance of 54 degrees. Mathematical equations were developed empirically to express the dependence of radiance or apparent sky temperature on zenith distance. Author

N65-34217*# Smyth Research Associates, San Diego, Calif.
RADIO METEOROLOGY AT JPL GOLDSTONE PIONEER STATION, JULY 14, 1965 Final Report
John B. Smyth and Leo B. Cashman Jul. 1965 30 p refs Prepared for JPL
(NAS7-100)
(NASA-CR-64972; SRA-462) CFSTI: HC $2.00/MF $0.50 CSCL 04B

The purpose of this investigation was twofold: to determine the macroscopic refractive index structure of the tropospheric region through which the Marine–Mars signals were propagating and to evaluate the local microscopic refractive index variations which could cause significant phase variations of the received signal during the time of the measurements around 7:00 p.m., July 14, 1965. A study of meteorological data taken from radiosonde ascents above Yuma, San Diego, and Las Vegas together with surface observations at Goldstone yielded a value of 2.27 ±0.03 meters for the radio depth of the troposphere. If the air between two and five kilometers had been saturated, an additional 0.14 meter path length would have resulted. Cumulus cloud activity could cause changes of this magnitude. Fortunately, no such clouds were present along the transmission path. It is extremely unlikely that fluctuations as large as ±0.02 meters took place over the Pioneer Station during the time interval 1900–2000 on July 14, 1965. Author

N65-34271# Inter-Range Instrumentation Group, White Sands Missile Range, N. Mex.
PACIFIC MISSILE RANGE REFERENCE ATMOSPHERE FOR ENIWETOK, MARSHALL ISLANDS, PART I, AUGUST 7, 1964
Dec. 1964 87 p refs
(IRIG-104-63; AD-461402)

Explanation of the basic data, computational procedures, and the resulting values tabulated for altitude intervals between mean sea level and 30 km altitude are presented and monthly and annual thermodynamic values and wind quantities are tabulated. The thermodynamic quantities are height, pressure, temperature, virtual temperature, density, speed of sound, relative humidity, and vapor pressure tabulated at 250 m intervals of geometric altitude. The wind quantities are scalar wind, zonal and meridional component values for eleven cumulative percentage frequency levels tabulated at 1 km intervals from 0 to 27 or 30 km altitude. E.E.B.

N65-34275# Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex. Meteorological Support Div.
NIKE-CAJUN NICAP/1, ROUND NO. 013 (24 JUNE 1965) Meteorological Data Report
Lon E. Carter Aug. 1965 26 p
(ERDA-330; AD-468975)

Meteorological data collected for the launching of Nike-Cajun NICAP/1, Round No. 013, are presented. The meteorological data and resulting ballistic data appear in tabular form. Author

N65-34342# Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
ATHENA FLIGHT NUMBER 017 (26 JULY 1965) AND ATHENA FLIGHT NUMBER 018 (27 JULY 1965) Meteorological Data Report
Harold M. Richart Aug. 1965 86 p refs
(ERDA-335; AD-468708)

Meteorological data gathered for the launching of Athena Flight Number 017, Vehicle #C-011 and Athena Flight Number 018, Vehicle #D-005 are presented for the Air Force Ballistic Missile Re-entry Systems Office and for ballistic studies. The data are presented in tabular form. Author

N65-34458# Weather Bureau, Washington, D. C. National Severe Storms Lab.
A COMPARISON OF KINEMATICALLY COMPUTED PRECIPITATION WITH OBSERVED CONVECTIVE RAINFALL
James C. Fankhauser Sep. 1965 32 p refs *Its* Rept.-25
(TN-4-NSSL-25)

Observed wind and moisture patterns in an extensive squall-line development are used to compute precipitation from a continuity equation for moist air. Horizontal flux of water vapor accounts for about 80 percent of the observed rainfall, and when the local change in water vapor content is included in the moisture balance equation, the computed budget accounts for 95 percent of the actual rainfall production. Factors neglected in the quantitative assessment of the water budget are (1) the transport of water in liquid and solid state and (2) the evaporation from the ground. The results obtained indicate that the agreement between kinematically computed precipitation and observed rainfall improves with the density of rawinsonde observations. Small directional shear in the vertical wind field is proposed as a mechanism for making the squall line an efficient rainfall producer. Author

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N65-33802*# National Aeronautics and Space Administration, Washington, D. C.
METHOD OF AUTONOMOUS GUIDANCE DURING FLIGHTS IN NEAR-PLANET ORBITS [METOD AVTONOMNOY NAVIGATSII PRI POLETAKH PO OKOLOPLANETNYM ORBITAM]
I. K. Bazhinov May 1965 11 p Transl. into ENGLISH from RUSSIAN Presented at the 2d Ann. Conf. of the Am. Astronautical Soc., Chicago, 4–7 May 1965
(NASA-TT-F-9542) CFSTI: HC $1.00/MF $0.50 CSCL 17G

A method for autonomous navigation of a spacecraft, under full control of the astronauts, is described, based on practical experience of the Voskhod-2 flight. Conventional navigation methods are used on board the craft, taking fixes on two heavenly bodies preselected by the ground station before blast-off. The times t_1 and t_2 at which these bodies are at a predetermined altitude above the planet horizon and the

period of revolution of the craft are used in computing the time of cut-in of the retro rockets for transfer to a parking orbit or for soft landing on the planet. Author

N65-33816*# Consultants and Designers, Inc., Arlington, Va.
RENDEZVOUS PROBLEM OF SPACE VEHICLE WITH ORBITAL STATION [NEKOTORYYE VOPROSY SBLIZHENIYA S ORBITAL'NOY STANTSIEY]
G. Yu. Markov and F. A. Mikhaylov 21 Jun. 1965 11 p refs Transl. into ENGLISH of a paper Presented at the Intern. Federation of Autom. Control, Stavanger, Norway, 21–25 Jun. 1965
(Contract NAS5-3760)
(NASA-TT-F-9688; ST-CM-GC-10346) CFSTI: HC $1.00/MF $0.50 CSCL 17G

Considering that the various schemes of spacecraft rendezvous with oribtal station consist of three stages, and that either of these stages consists in its turn of three phases, the present work is devoted to the problem of spacecraft guidance at long-range rendezvous phase with orbital station, utilizing the second derivative of the relative remoteness for information on line-of-sight-rotation. Author

N65-33844*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DEVELOPMENT AND TESTING OF A PROPOSED INFRARED HORIZON SCANNER FOR USE IN SPACECRAFT ATTITUDE DETERMINATION
Norman M. Hatcher, Arthur L. Newcomb, Jr., and Nelson J. Groom Washington, NASA, Sep. 1965 36 p refs
(NASA-TN-D-2995) CFSTI: HC $2.00/MF $0.50 CSCL 17G

An attitude sensing horizon scanner for spacecraft that detects the thermal radiation discontinuity at opposite horizons of a planetary body to determine spacecraft attitude has been designed. An experimental model, incorporating many of the features of the proposed scanner, has been constructed and used for testing purposes. Results of tests with the experimental model indicate that the proposed scanner could perform as predicted earlier in a theoretical report (NASA Technical Note D-1005) on the scanner design. That is, it would have an instrument-associated error of less than 0.1°, a signal-to-noise ratio that would allow it to operate at altitudes of about a million miles from the earth, a power consumption rate of about 3.5 watts, the ability to reject signals from the sun, and a wide-angle capture capability. An alternate solenoid-type scanning-mirror drive mechanism for the scanner has been examined. Laboratory tests with an experimental model of the drive system indicate that it could be effectively used to further increase lifetime while decreasing weight, volume, and power consumption. Author

N65-33964*# Consultants and Designers, Inc., Arlington, Va.
ATTITUDE RESTORATION OF A MISSILE WITH THE AID OF THREE MAGNETOMETERS AND AN EMITTING ELECTRIC DIPOLE [RESTITUTION DE L'ATTITUDE D'UN ENGIN A L'AIDE DE TROIS MAGNETOMETRES ET D'UN DIPOLE EMETTEUR]
Francois Bertin and Jacques Papet-Lepine [1965] 7 p ref Transl. into ENGLISH from Compt. Rend. Acad. Sci. Astronautique (Paris), v. 260, 12 Apr. 1965 p 4147–4150
(Contract NAS5-3760)
(NASA-TT-F-9699; ST-GC-10387) CFSTI: HC $1.00/MF $0.50 CSCL 17G

The simultaneous measurement of the earth's magnetic field and of the electromagnetic field of a wave, emitted by a dipole placed on the missile, allows to determine unambiguously and at any chosen time the latter's attitude. Author

N65-33992# Federal Aviation Agency, Atlantic City, N. J.
ANALYSIS OF RUNWAY MARKING CONFIGURATIONS FOR BRIGHT DAYLIGHT CONTACT FOG OPERATIONS Interim Report
Robert K. Mc Kelvey and Guy S. Brown Nov. 1964 79 p refs (RD-64-154; AD-618678)

Four experiments were conducted to determine the feasibility of utilizing runway marking to provide guidance for visual transition for landing and for monitoring of runway distance to go. The experiments were done in a visual landing simulator modified to present the field and brightness contrast relationships characteristic of a bright daylight contact fog with a visual range of approximately 1,200 feet. The results suggest that it is feasible to provide visual support under the specified visibility conditions with patterns compatible with the standard narrow gauge touchdown lighting configuration. In addition, it appears possible that these systems can be designed without marking elements in the critical centerline wear area of the landing zone and in "double ended" versions providing distance to go information. Future work will attempt to extend the distance indicating code to a configuration adequate for 12,000 feet, as well as for the 7,000-foot runway used in these experiments. Author

N65-34083# Ministry of Aviation, Pinner (England). Aeronautical Information Service.
DETECTION AND AVOIDANCE OF MOUNTAIN WAVE SYSTEMS: SAFETY HEIGHTS OVER HIGH GROUND
R. G. K. Way 19 Oct. 1964 15 p
(JH-52-01-SF(B)1) CFSTI: HC $1.00/MF $0.50

The dynamic effects of mountain waves are described, and their hazards to aviation, together with the related safety height and avoidance criteria, are outlined. These lee waves are frequently produced when, in stable atmospheric conditions, the normal horizontal airflow is disturbed by a mountain range and forms characteristic lenticular clouds at the wave crest. The dangerous turbulent rotor systems that tend to form in the crests of these waves can be avoided by flying at an adequate height margin of at least 2,000 ft above ground. An aircraft flying downwind of an initiating ridge can be subject to downdraft and adiabatic cooling resulting in severe airframe icing. Also, rapid variations in the direction and speed of the horizontal wind might lead to significant tracking errors. G.G.

N65-34434*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A GENERAL DESCRIPTION OF THE ST124-M INERTIAL PLATFORM SYSTEM
Herman E. Thomason Washington, NASA, Sep. 1965 93 p refs
(NASA-TN-D-2983) CFSTI: HC $3.00/MF $0.75 CSCL 17G

A general description of the ST124-M inertial platform system is presented. The major subsystems of the platform system are discussed and a brief explanation of the launch electrical support equipment is provided. Servoloop design theory for use with gas bearing components and an extension of this theory into the three-axis platform servosystem is presented. The effects of gyro cross-coupling and three-axis stabilization problems are discussed. Each of the platform's subsystems is discussed to the extent that a general understanding of its function is possible. References are provided to facilitate further investigation. Author

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N65-33741# Atomics International, Canoga Park, Calif.
U – 10 WT% MO FUEL ELEMENT, IRRADIATION IN SRE
J. L. Arnold, K. J. Miller, and R. M. Peterson 31 Aug. 1965 35 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-11121) CFSTI: $2.00

A partial prototype of a Hallam Core I fuel element, containing U-10 wt% Mo fuel alloy, was fabricated and irradiated in a sodium reactor experiment. Maximum burnup of 5300 Mwd/MTU, at a peak fission rate of approximately 1.5×10^{13} fissions/cm^3-sec, and at a maximum central temperature near 1200° F resulted in fuel rod low fission gas release of 0.1%. Fuel dimensional changes of the rods ranged from −0.2% to +2.2% with corresponding density decreases from 0.2% to 6.4%. Fuel slugs which had burnups less than 4,000 Mwd/MTU were in excellent condition, but fuel slugs with greater burnups showed extensive surface cracking and greater fuel dimensional changes. The structure of fuel with no surface cracking was essentially in the γ phase; slugs which experienced surface cracking showed structural transformations to the $\alpha + \gamma'$ phase. It was concluded that a lifetime limit of the HNPF Core I U-10 wt % Mo fuel elements below a burnup of 4,000 Mwd/MTU is unlikely, and a maximum burnup of 6,000 Mwd/MTU may be achieved. G.G.

N65-33783# Martin Co., Baltimore, Md. Nuclear Div.
FINAL SAFETY EVALUATION OF A SIXTY WATT STRONTIUM 90 FUELED GENERATOR FOR A U. S. COAST GUARD AUTOMATIC LIGHT STATION, SNAP 7B
V. G. Kelly and H. N. Berkow May 1962 31 p refs
(Contract AT(30-1)-2345)
(MND-P-2762-A)

Safety design criteria for the SNAP-7B thermoelectric generator system were evaluated for their mechanical, thermal, and radiation integrity to assess the radiobiological effects in the event of release of the radioisotopic fuel. Assumed was a fuel loading of 245,000 curies of radiostrontium. It was concluded that: (1) Encasing of the radiostrontium fuel in two independent pressure vessels, each of which will withstand 5,350 psi, will insure generator safety at an ocean depth of 12,000 feet; (2) Fuel containment will be maintained even if some of the internal components melt; (3) The outer shield container will withstand all credible accidents during impact; (4) The chemical stability and insolubility of the fuel prevent it from becoming a radiological hazard in the event of containment loss due to sea burial; (5) Corrosion danger is practically eliminated by a capsule weld penetration depth of 0.090 inch, and the use of Hastelloy C; (6) Shipment under ICC regulations is assured; (7) Fuel radiation will hardly effect the generator material; and (8) Strict quality control during manufacturing and assembly is essential. G.G.

N65-33828*# Aerojet-General Corp., Azusa, Calif.
SNAP-8 ELECTRICAL GENERATING SYSTEM DEVELOPMENT PROGRAM Seventeenth Quarterly Progress Report, Jun.–Aug. 1964
Oct. 1964 225 p refs *Its* Rept.-0390-04-17
(Contract NAS5-417)
(NASA-CR-54219) CFSTI: HC $6.00/MF $1.25 CSCL 18N

The objective of the SNAP-8 Program is to design and develop a 35-kw electrical generating system for use in various space missions. This report covers the progress during the seventeenth quarter of contract performance by the Aerojet-General Corporation.The status of the various necessary systems analyses is presented. Design and fabrication of components—turbine alternator assembly, NaK and mercury pump-motor assemblies, bearings, seals-to-space, mercury boiler and and condenser, mercury injection system, electrical insulation, and electrical components—are reported. Testing the several component test loops is discussed. Materials evaluation of components exposed to mercury corrosion and erosion is presented. Author

N65-33938# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucléaires.
THE REPROCESSING OF IRRADIATED FUELS BY HALIDES AND THEIR COMPOUNDS [LE TRAITEMENT DES COMBUSTIBLES IRRADIES PAR LES HALOGENES ET LEURS COMPOSES]
Michel Bourgeois and Pierre Faugeras 1964 15 p refs In FRENCH; ENGLISH summary
(CEA-R-2667) CFSTI: HC $1.00/MF $0.50

A brief description is given of the experiments leading to the choice of the process of volatilization of fluorides by gas phase attack. The chemical process is described for certain current types of clad fuels; the aluminum or the zirconium cladding is first volatilized as chloride by attack with gaseous hydrogen chloride. The uranium is then transformed into volatile hexafluoride by attack with fluorine. These reactions are carried out consecutively in the same reactor in the presence of a fluidized bed of alumina which facilitates heat exchange. The experiments have been carried out in quantities from 100 gms to several kilograms of fuel, first without activity, and then with tracers. Author

N65-33989# Atomics International, Canoga Park, Calif.
CARBIDE FUELS IN FAST REACTORS
C. W. Wheelock 15 Sep. 1965 77 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-10751) CFSTI: $3.00

Plutonium-uranium carbide shows promise of becoming an outstanding fuel for Fast Breeder Reactors (FBR). The requirements for FBR fuels, including specific power, fuel rod size, temperature, burnup levels, and processing costs are discussed; insofar as they are interrelated and affect fuel cycle costs. Applicable laboratory and irradiation data and observations for uranium carbide fuels are integrated with the more limited data available on mixed carbides, (U, Pu)C. Cladding and fuel material processing prospects are reviewed, and fuel system possibilities for near-term (~1 mill/kwh) and long-range (< 0.5 mill/kwh) fuel cycles are described. Author

N65-34019# Pratt and Whitney Aircraft, Middletown, Conn.
DEVELOPMENT OF LCRE LIQUID METAL PUMPS AND SUMPS Final Report
Sep. 1965 327 p refs
(Contract AT(30-1)-2789)
(PWAC-386)

The proposed ground test of the Lithium-Cooled Reactor, designated LCRE, required the development of centrifugal pumps mounted in sumps to circulate the lithium primary coolant at 1000F, the NaK-78 secondary coolant at 700F and the NaK-78 reflector coolant at 700F. All three pumps utilized anti-friction shaft support bearings lubricated and cooled by Mil-L-7808D oil and were powered by gas-cooled electric motors. Primary sealing of the liquid metal was accomplished

with centrifugal dynamic shaft seals, which maintained a liquid metal-to-inert gas interface on the rotating vanes of the dynamic seal impeller. Secondary sealing was provided by inert gas sweep systems and cermet-faced mechanical shaft seals. Extensive testing of pump components, as well as water and liquid tests of complete pump assemblies, were accomplished to meet the program objectives of high performance and high reliability for the expected total operating lifetime of 15,000 hours. Over 60,000 hours of component face seal testing and over 74,000 hours of pump testing in liquid metal were conducted. Several successful liquid metal tests of 10,000 hours duration were accomplished with the LP-1 lithium and NP-1 NaK pumps prior to termination of the LCRE program. Author

N65-34190# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

FAST NEUTRON FLUX CHARACTERISTICS OF THE ETR, G-7 HOT WATER LOOP

A. L. Bement, R. E. Dahl, and J. E. Irvin Aug. 1965 78 p refs
(Contract AT(45-1)-1830)
(BNWL-89) CFSTI: $3.00

In the course of conducting irradiations on reactor structural materials in the ETR, G-7, hot-water loop, nearly 1000 dosimeters of Fe, Ni, Ti, and Al-0.1 wt% Co were activated, counted, and analyzed. From these measurements, the mean spatial neutron flux distribution in the G-7 position was mapped, and variations in the flux intensity and configuration of this distribution from cycle to cycle were determined. The greatest reliability in flux measurement was obtained with iron detectors counted nondestructively. Flux values measured from nickel dosimeters were often erratic, particularly after long exposures where corrections of the thermal neutron burnout of cobalt are expectantly inaccurate. The accuracy in measured flux was estimated to be within ±10%, and flux maps and spatial coefficients were derived which permitted calculating the flux at any position within the loop within ±20% accuracy. A 4 to 8% correction resulted in normalizing the effective cross sections for iron and nickel, respectively, over the slightly-moderated ETR spectrum compared to a fission spectrum for energies above 1 MeV. Author

N65-34201# Oak Ridge National Lab., Tenn.

NUCLEAR SAFETY PROGRAM Semiannual Progress Report, Period Ending Jun. 30, 1965

William B. Cottrell et al Sep. 1965 286 p refs
(Contract W-7405-ENG-26)
(ORNL-3843) CFSTI: $6.00

Nuclear reactor safety programs are presented with a particular view toward their application in populated reactor site areas. The most important hazard considered is the release of fission products to the environment, as understanding the behavior of fission products in all phases of a nuclear accident allows a realistic evaluation of reactor sites. These studies included: (1) release and transport of fission products upon in-pile destruction of reactor fuels; (2) release and transport behavior of fission products in containment systems; (3) filtration and adsorption under accident conditions; and (4) characterization and behavior of accident-released fission products. W.M.R.

N65-34355# United Kingdom Atomic Energy Authority, Harwell (England). Chemistry Div.

HARWELL PILE OSCILLATOR MEASUREMENTS ON THE RELATIVE NEUTRON YIELDS OF URANIUM 233, URANIUM 235 AND PLUTONIUM 239

M. J. Cabell, H. Rose, and R. B. Tattersall London, HMSO, Jun. 1965 43 p refs
(AERE-R-4946) CFSTI: HC $2.00/MF $0.50

The results of an extensive series of pile oscillator measurements at Harwell on the relative neutron yields of U^{233}, U^{235}, and Pu^{239} are presented. Good agreement is found with world data for η, but there is an apparent discrepancy of some 3% in the reactivity effect of U^{233} from British and American sources. This discrepancy appears to be outside the experimental errors, and no satisfactory explanation has yet been found. The 2200 m/sec. η-ratios obtained using the average results from all samples were for U^{233}/U^{235} 1.102 ±0.014 and 1.008 ±0.011 for Pu^{239}/U^{235} Author

N65-34363# General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.

HIGH POWER DENSITY DEVELOPMENT PROJECT Quarterly Progress Report No. 19, Oct. 1964–Feb. 1965

R. L. Holladay, comp. 1 Mar. 1965 41 p refs
(Contract AT(04-3)-361)
(GEAP-4816) CFSTI: $3.00

Experiments and calculations are reported in development of high power density (HPD) assemblies. Evaluation of calculated fuel burnup and fast neutron cladding exposure values have resulted in a reduction in the calculated peak fuel burnup for some HPD assemblies. Metallographic examination of uranium oxide fuel rods formed by vibratory compaction is discussed. Use of stainless steel in cladding uranium oxide is reported. Measurements of in-core power and flow were made with an instrumented HPD fuel assembly during full-power tests. Fuel placement and control rod patterns are specified for an 84-bundle core which will allow full-power operation for a period of 4 to 6 months. Programming and debugging of all on-demand logs for the on-line computer are complete. J.M.D.

N65-34396*# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.

TUNGSTEN CLADDING OF REACTOR FUELS

J. Lindgren, A. Weinberg, N. Elsner, and R. Holzl (San Fernando Labs.) 6 Nov. 1963 13 p refs Presented at the Symp. on Appl. of Refractory Metals, Los Angeles, 9–10 Dec. 1963
(Contract NAS3-2532)
(NASA-CR-67050; GA-4764) CFSTI: HC $1.00/MF $0.50
CSCL 18J

Tungsten cladding of reactor fuels including UC, UC-ZrC, W-UC, and W-UO_2 cermets is investigated. Two different methods of tungsten cladding are described: one method utilizing vapor-deposition, and the other, a machined W-2Mo alloy cup whose inside surface is clad with vapor-deposited tungsten with a diffusion bonded cap. Also considered is a program to develop a more suitable method for coating carbides. Results indicate that a vapor-deposited tungsten coating could be applied with no significant attack on the carbide. When carbides with protective coatings 1-1/2 to 5 mils thick were heated in HF for one half hour at 700° C, it was found that a 3-mil coating gave adequate protection, provided that the coating had no holes. The results showed that tungsten-vapor deposition is a fabrication method amenable to the cladding of complex shapes. G.A.L

N65-34410*# Space Technology Labs., Inc., Redondo Beach, Calif.

MISSION ORIENTED ADVANCED NUCLEAR SYSTEM PARAMETERS STUDY. VOLUME II: DETAILED TECHNICAL REPORT, MISSION AND VEHICLE ANALYSIS Final Report, Apr. 1963–Mar. 1965

Mar. 1965 202 p refs
(Contract NAS8-5371)
(NASA-CR-67146; STL-8423-6006-RU-000) CFSTI: HC $6.00/MF $1.25 CSCL 21F

Two mission analysis computer programs for the IBM 7094 were developed to evaluate the various nuclear engine, vehicle system, and mission parameters for nuclear propulsion system applications in the 1975–1990 time period. Over 20000 mission simulations were generated using the Swingby Optimization Program (SWOP) and the Flyby Optimization Program (FLOP), and optimum trajectory and vehicle was determined for each simulation. Design characteristics and optimum thrust range are given for an advanced nuclear engine; and sensitivity of the vehicle to variations in mission, engine, and vehicle parameters is established. Initial vehicle weight requirements were established for earth orbit in order to perform a variety of interplanetary missions. Mars stopover, flyby and other missions are considered; and Venus stopover and lunar transfer missions requirements are also established. M.W.R.

N65-34440# Los Alamos Scientific Lab., N. Mex.
ADVANCED REACTOR TECHNOLOGY (ART) Quarterly Status Report, Period Ending Jul. 31, 1965
31 Aug. 1965 63 p refs
(Contract W-7405-ENG-36)
(LA-3370-MS) CFSTI: $3.00

The following data on some aspects of advanced reactor technology are presented: (1) Plutonium reactor core test facility—sodium system and hot trap design, data and gas cleanup system, exhaust filter train, and molten plutonium burnup experiment; (2) Supporting research and development—plutonium carbides, thermodynamic properties, electronic specific heat, plutonium nitrides, self-radiation damage of refractory Pu compounds, and compressibility of liquid fuel alloy; (3) Ultra high temperature reactor experiment (UHTREX) construction and equipment installation—reactor components, helium blower tests, coolant systems, graphite studies, and UHTREX critical experiment; (4) MHD applications; (5) Plasma thermocouple; and (6) Heat pipes. R.W.H.

N65-34672# Bettis Atomic Power Lab., Pittsburgh, Pa.
THE STEADY CREEP SWELLING OF A CLAD NUCLEAR FUEL PLATE
N. C. Small Jul. 1965 22 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-498) CFSTI: $1.00

An analysis is presented for the steady creep swelling of a long clad nuclear fuel plate due to fission gases. The effect of this gas pressure is represented by a dilatation term in the equations which also allow for the inelastic compressibility resulting from external constraints (cladding). The problem is idealized as a semi-infinite clad plate on a dilatating foundation (fuel). Alternative one-dimensional strain and stress models are presented for the foundation, and emphasis is placed on the cladding deformation in the vicinity of the edge. An approximate solution is obtained for the stress model utilizing a combination of the collocation and minimum potential energy methods. The results show that, for the range of parameters considered, the cladding reaches its maximum lateral displacement at about three cladding thicknesses from the edge. Author

N65-34701# Los Alamos Scientific Lab., N. Mex.
NRDS ANALYSIS OF THE KIWI B-4D-202 NUCLEAR REACTOR CONTROL SYSTEM
Thomas O. Hearn 20 Sep. 1965 109 p refs
(Contract W-7405-ENG-36)
(LA-3301-MS)

This report was written to summarize the technique used in controlling nuclear rocket engines. It is hoped that it might serve as an introduction into the specific control problems associated with such nuclear devices, with additional detailed information available as referenced. The control systems used with the Kiwi B-4D-202 reactor series are evaluated through the use of an analog computer simulation. The three modes of control discussed are: (1) automatic reactor startup, (2) power control, and (3) power-temperature control. A brief analysis of the B-4E-301 temperature control system is also included. Author

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N65-33655*# Texas A&M Univ., College Station.
[INTERDISCIPLINARY SPACE-ORIENTED RESEARCH PROGRAM IN THE PHYSICAL, LIFE, AND ENGINEERING SCIENCES] Progress Report
Harry E. Whitmore Aug. 1965 231 p refs
(Grant NsG-239-62)
(NASA-CR-64819) CFSTI: HC $6.00/MF $1.25 CSCL 20

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3. COMPUTATIONAL METHODS IN THE SOLUTIONS OF ATOMIC AND SOLID STATE PHYSICS PROBLEMS: HYPERFINE STRUCTURE OF LITHIUM D. L. Hardcastle 9 p refs (See N65-33658 22-24)

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6. A GENERAL THEORY OF THIN ELASTIC SHELLS OF PLANE ANISOTROPIC MATERIALS H. J. Sweet 59 p refs (See N65-33659 22-32)

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8. SOLUTIONS OF ELASTICITY PROBLEMS USING BOUNDARY CONDITIONS OBTAINED EXPERIMENTALLY J. G. H. Thompson 17 p (See N65-33661 22-32)

9. CHARACTERISTICS OF SOLID PROPELLANT OXIDIZER SUSPENSIONS P. T. Eubank and B. F. Fort 3 p ref (See N65-33662 22-27)

10. MAGNETIC PROPERTIES OF SOLIDS C. F. Squire, T. W. Adair, R. Zamecki, and E. Sharp 20 p refs (See N65-33663 22-26)

11. A STUDY OF CADMIUM ABSORPTION OF RESONANCE NEUTRONS IN VARIOUS FOIL MATERIALS R. G. Cochran, J. E. Powell, and R. T. Perry 15 p (See N65-33664 22-24)

12. GAS DYNAMIC STUDIES IN AN ARC-DRIVEN SHOCK TUBE R. E. Thomas and G. L. Huebner, Jr. 8 p ref (See N65-33665 22-12)

13. RESEARCH IN ELECTRICAL ENGINEERING M. G. Rekoff, Jr. and Donald F. Sellers 6 p

N65-33782# California Univ., Livermore. Lawrence Radiation Lab.
FRESNEL ZONE PLATES FOR FOCUSING MICROWAVES
Ronald S. Hawke 7 Jan. 1964 16 p refs
(Contract W-7405-ENG-48)
(UCRL-7785-T)

The operation of a simple Fresnel zone plate is shown in a geometrical representation, and a design procedure is given for half-wavelength and quarter-wavelength Fresnel zone lenses. Constructed was a quarter-wavelength lens able to concentrate 35- and 70 Gc microwaves into an area with a three-wavelength diameter. Calculations of the expected gain were compared to measured values from a detector probe containing a narrowed boron nitride rod. The gain along the center line was measured as a function of the distance between the lens and the probe, and the beam width of the focused field was measured at the point perpendicular to the center line axis, at which the field strength was 3 db less than the center line value. The maximum gains measured were 23.0 db at 35 Gc, and 22.2 db at 67 Gc. Discrepancies between the calculated and measured values were attributed to reflections from the surface of the lens, dielectric losses in the lens, and any non-sphericalness of the incident phase front. G.G.

N65-33822*# Consultants and Designers, Inc., Arlington, Va.
ON THE STABILITY OF EQUILIBRIUM STATES OF THE NON-HOLONOMIC SYSTEMS [OB USTOYCHIVOSTI SOSTOYANIY RAVNOVESIYA NEGOLOMNYKH SISTEM]
Yu. I. Neymark and N. A. Fufayev 31 Aug. 1965 8 p refs
Transl. into ENGLISH from Mekhan., Dokl. Akad. Nauk SSSR (USSR), v. 160, no. 4, 1965 p 781–784
(Contract NAS5-3760)
(NASA-TT-F-9696; ST-CM-10377) CFSTI: HC $1.00/MF $0.50 CSCL 20K

Presented is a theoretical analysis on the stability of the equilibrium states of nonholonomic systems. It is shown that a nonholonomic system is peculiar in that its equilibrium states cannot be isolated, and that they form a variety whose dimensionality is equal to the number of equations of nonholonomic liaisons. Considered are contrasting theories concerning the presence or absence of zero radicals in the characteristic equation. Also analyzed is a proposed theorem concerning the asymptotic stability of manifold states of equilibrium. Included are examples which are presented in support of this theorem. S.C.W.

N65-33909# Harvard Univ., Cambridge, Mass. Cruft Lab.
OBTAINING THE EQUATIONS OF MOTION FOR PARAMETRICALLY COUPLED OSCILLATORS OR WAVES
A. E. Siegman 3 May 1965 21 p refs
(Contract Nonr-1866(16))
(TR-469; AD-618410)

By employing appropriately defined normal mode amplitudes as variables, one can cast the equations of motion for any parametric system into a general coupled-mode form, where this form depends on the number of frequency components present and on the order of the nonlinearities present, but not on any other details of the particular physical system. This note gives a simple procedure, based on a hamiltonian approach, by which one may obtain the general form of the equations of motion for any multifrequency parametric system, including parametrically coupled oscillators with growth in time, parametrically coupled running waves with growth in distance, and parametrically coupled running waves with growth in both time and distance. The general equations obtained by this procedure are useful for pedagogic purposes and general discussions; as a means of either avoiding the need for, or checking the results of, more complicated derivations on specific physical systems; as the starting point for quantizing the parametric system; and as a means of proving the Manley-Rowe relations, which emerge very directly from the resulting general equations. Author

N65-33934# Royal Inst. of Tech., Stockholm (Sweden). Speech Transmission Lab.
SPEECH TRANSMISSION LABORATORY QUARTERLY PROGRESS AND STATUS REPORT, APRIL–JUNE 1964
15 Jul. 1964 46 p refs
(STL-QPSR-2/1964; AD-460984) CFSTI: HC $2.00/MF $0.50

Vocal data on variation in frequencies during vowel formation are presented. Spectrographic measurements of vowel formant frequencies and vowel duration were made for a set of tense and lax Swedish vowels produced at varying talking rates in the environment of voiced dental stops. Also, cineradiographic data are used to illustrate the articulatory processes underlying vowel reduction. In a separate study using a decompression chamber, the velar function of a subject during phonation was investigated to explore the distortion of diver's speech at deep underwater levels. J.M.D.

N65-33986# Brown Univ., Providence, R. I. Div. of Applied Mathematics.
CALCULATIONS OF THE CONDUCTIVITY OF A MEDIUM CONTAINING CYLINDRICAL INCLUSIONS BY THE METHOD OF ORTHOGONALIZED PARTICULAR SOLUTIONS
Philip Rabinowitz (Weizmann Inst. of Science) [1965] 17 p refs
(Contract Nonr-562(36))
(AD-618052)

Calculations of the conductivity of an infinite medium containing a square array of perfectly conducting cylindrical inclusions were carried out using the method of orthogonalized particular solutions. The results agree with those reported by Keller and Sachs using the method of finite differences. Author

N65-34065# Rhode Island Univ., Kingston.
THE SUPERPOSITION PRINCIPLE AND DIFFRACTION IN ANGULAR SECTIONS
Julius Kane (Calif. Inst. of Tech.) Bedford, Mass., AFCRL, Feb. 1965 28 p refs *Its* Sci. Rept. 5
(Contract AF 19(604)-7983)
(AFCRL-65-94; AD-612654)

The powerful, but abstruse and complicated procedures used by Peters and Senior to solve diffraction problems in wedge shaped regions are shown to have a simple characterization in terms of the superposition principle. By a generalization of the dual integral equation approach used to analyze Wiener-Hopf problems, integral representations for the solutions of such problems as the scattering of waves in an angular sector with arbitrary mixed boundary conditions imposed on the boundaries of the sector can be readily found. Author

N65-34137# Massachusetts Univ., Amherst. Polymer Research Inst.
THE DEPENDENCE OF LIGHT SCATTERING BY POLYMER FILMS ON POLARIZATION ANGLE, AND ITS RELATIONSHIP TO THE RANDOMNESS OF ORIENTATION FLUCTUATIONS
Richard S. Stein, Peter Erhardt, and George Adams 1 Jul. 1965 68 p refs
(Contract Nonr-3357(01))
(ONR-TR-74; AD-619677)

A theory for scattering from polymer films having non-random-orientation fluctuations is presented that involves a parameter ϵ that varies between +1 for rodlike orientation

correlations and −1 for disklike correlations. A value of $\epsilon = 0$ corresponds to random correlations where the probability of optic axes being parallel is independent of the relative orientation of the axes and their line of separation. This is the previous case of random-orientation fluctuations that have been previously treated and that lead to correlated regions within the polymer having average spherical shape. The variation of the scattering with the angle ψ characterizing the orientation of a polarizer in the incident light beam is found to depend upon the parameter ϵ. Intensity variations are calculated for the cases where an analyzer in the scattered beam has its depolarization direction either parallel or perpendicular to that of the polarizer. This approach is useful for describing the morphology of a crystalline polymer with organization less than that of a spherulitic polymer but greater than random. Author

N65-34148# Stanford Univ., Calif. Electron Devices Lab.
DEMODULATION OF FREQUENCY OR SPACE MODULATED LIGHT Final Report
J. R. Kerr Mar. 1965 202 p refs *Its* Tech. Rept.-0577-4
(Contract DA-36-039-AMC-00094(E))
(SEL-65-033; AD-619400)

This study is concerned with the generation and detection of a light beam which is deflected back and forth at a microwave rate in accordance with frequency modulation on the beam. Deflection was achieved by sending the frequency modulated light through a dispersing element. The detection system consisted of a photocathode which emitted a transversely modulated electron beam into a transverse-field interaction circuit. General analyses were developed for the dispersion and electron beam-circuit interaction systems. The applicability of the instantaneous-frequency viewpoint was explored in detail, and a new condition for the validity of this viewpoint was derived. Phototube design procedures were formulated. Experiments demonstrated the dispersion and interaction mechanisms, including an unforeseen effect involving partial interception of the deflected light beam. The experiments supported the detailed theoretical analyses. An examination of the basic noise limitation revealed a significant advantage over certain other FM light detection systems. Author

N65-34153# New York Univ., N. Y. Div. of Electromagnetic Research
ASYMPTOTIC EXPANSIONS OF SOLUTIONS OF INITIAL-BOUNDARY VALUE PROBLEMS FOR A DISPERSIVE HYPERBOLIC EQUATION
Norman Bleistein and Robert M. Lewis Jun. 1965 41 p
(Contract AF 19(628)-4065)
(EMp-207; AFCRL-65-456; AD-619957)

Initial-boundary value problems for an energy conserving dispersive hyperbolic equation, the Klein-Gordon equation, are considered. This equation exhibits the main feature of dispersion: The speed of propagation depends on frequency. Problems in two space dimensions with a parabolic boundary are discussed. The primary purpose of this paper is to compare the asymptotic expansion of solutions obtained by a technique we call the *ray method* with the asymptotic expansion of the exact solution. In the cases considered, the solutions agree. In addition a numerical comparison is made of the exact and asymptotic solutions for a specified region of space time. Author

N65-34234*# National Aeronautics and Space Administration, Washington, D. C.
ELECTRON PROBE MICROANALYZER: STUDY OF THE FLUORESCENCE EXCITED BY CONTINUOUS RADIATION [MICROANALYSEUR A SONDE ELECTRONIQUE: ETUDE DE LA CORRECTION DE FLUORESCENCE DUE A SPECTRE CONTINU]
Jean Henoc, Francoise Maurice, and Alexis Kirianenko Sep. 1965 71 p refs Transl. into ENGLISH of the Commissariat A.l'Energie Atomique Report No. CEA-R-2421, Saclay, France, 1964
(NASA-TT-F-9550) CFSTI: HC $3.00/MF $0.75 CSCL 20D

In order to permit the estimation of the correction due to fluorescence excited by continuous radiation, we have, on the one hand, determined experimentally on a set of pure elements the ratio of the fluorescent emission to the total characteristic radiation leaving the specimen and, on the other hand, calculated on the same elements the intensity of fluorescence excited by continuous radiation by means of a formula already established by one of us. The complicated part of this formula has been previously calculated on an IBM computer. A few examples of fluorescence calculations are given to illustrate the use of the values obtained. Author

N65-34262# Stevens Inst. of Tech., Hoboken, N. J. Davidson Lab.
MAGNETIC-FLUX COMPRESSION IN AN EXPLOSION GEOMETRY
S. J. Lukasik, G. W. Zepko, and R. L. Jameson (Aberdeen Proving Grounds) Jun. 1965 38 p refs
(Contract DA-30-069-ORD-3467)
(Rept.-1083; AD-468694)

A series of experiments has been performed to explore the utility of an explosion geometry for the compression of magnetic flux. Typically about 9,000 J of capacitively stored energy is discharged into a single-turn load coil having an inductance of about 40 nhy. The magnetic field so generated has a value at maximum discharge current of about 100 kg and a quarter-period of about 5 μsec. At this time the current supply is crowbarred, either by the 176-gm explosive compressor system located within the load coil or by means of an auxiliary explosive system. Thereafter, the radial expansion of the explosively driven liner compresses the magnetic flux within the load coil. Field-compression ratios in the range from 4 to 26 have been observed. The process terminates due to mechanical failure of the liner resulting from the magnetic pressure of the compressed field. The maximum field achieved in the experiments reported here was 1.33 megagauss; the field exceeded 1 Mg for 1.7 μsec. The hydrodynamic behavior of the expanding liner and the liner-load-coil interaction have been studied by means of high-speed photography. A series of animated framing-camera records in color have been assembled to illustrate the process. Author

N65-34265# Michigan Univ., Ann Arbor. Electron Physics Lab.
MICROWAVE PHENOMENA Interim Scientific Report, 1 Dec. 1964–1 Jun. 1965
G. I. Haddad, G. T. Konrad, R. L. Lomax, and J. E. Rowe Jul. 1965 112 p refs
(Contract AF 33(615)-1553)
(ISR-3; AD-469211)

The rf transmission measurements performed on the cold-cathode discharge tube, indicated an increased transmissi

around the plasma frequency. The infrared radiation spectrum from n-type GaAs was measured over a wide wavelength range, and its correlation with the V-I characteristic and the temperature of the sample was determined. A closed-form solution was obtained for the dispersion relation for wave propagation in a semiconductor material. The Boltzmann equation was employed, and a Maxwellian distribution was assumed. It was shown that instabilities may occur for a particular range of frequencies. An analysis of a ladder line periodically loaded with varactor diodes was also completed, showing that the circuit was suitable as a traveling-wave-parametric-amplifier (TWPA) circuit, as well as a voltage-tunable delay line and filter. A theoretical analysis on the down-conversion scheme for detection of millimeter- and submillimeter-wave radiation was performed. Results indicate that this detection scheme becomes essential at frequencies above 100 Gc because of the scarcity or nonexistence of power sources for use as local oscillators. R.W.H.

N65-34276# IIT Research Inst., Chicago, Ill. Technology Center.

ANALYSIS OF OPTICAL WAVEFRONT DISTORTIONS CAUSED BY THE ATMOSPHERE Interim Technical Report, 20 Jan.–20 Apr. 1965

Anthony J. Montgomery 5 May 1965 60 p refs

(Contract AF 33(615)-2429)

(IITRI-A6121-3; AD-465274)

A determination is made of the shape of an optical wavefront distortion caused by the atmosphere, in the absence of any other wavefront of known shape. Some methods of measuring image movement as distinct from wavefront distortion are discussed. In experiments conducted with laser beams along horizontal paths, it was found that exposure times of 1/300 sec were sufficiently short to freeze the pattern caused by transmission through the turbulent atmosphere. This indicates that the orientation of a wavefront arriving at an aerial camera aperture would not change in the period of a typical photographic exposure, provided that the relative positions of the source and camera remain fixed. The production of an interferometer system, that will permit the shape of the wavefront arriving at the camera aperture to be repetitively determined at approximately one-thousandth-of-a-second intervals, is investigated. Three types of shearing interferometer were considered: lateral, radial, and rotational. The advantages and disadvantages of these different types of interferometer are also discussed. G.A.L.

N65-34292# Columbia Univ., New York. Inst. for the Study of Fatigue and Reliability.

ON THE TWO-SIDED TIME-DEPENDENT BARRIER PROBLEM

M. Shinozuka and J. T. P. Yao Jun. 1965 31 p refs

(Contract Nonr-266(91)

(TR-21; AD-468997)

Upper and lower bounds are obtained for the probability that a separable random process X(t) will not be confined within the time-dependent barriers $-\lambda_1(t)$ and $\lambda_2(t)$ in the time interval [0,T] where $\lambda_1(t)$ and $\lambda_2(t)$ are positive (deterministic) functions of time. The method requires the random process to be neither stationary, Gaussian nor purely random (white noise). The present investigation is an extension of the previous work by Shinozuka (1965) with constant barriers $-\lambda_1$ and λ_2. The result of the present study can be applied to one of the most important problems in reliability analysis where the probability of failure of a mechanical system in the time interval [0,T] is to be evaluated under the condition that the failure of the system occurs when the random response X(t) (stress, strain or displacement) of the structure to external random excitation, such as wind loading or earthquake disturbance, reaches either one of critical values $-\lambda_1(t)$ in negative and $\lambda_2(t)$ in positive direction in that time interval. The functions $\lambda_1(t)$ and $\lambda_2(t)$ are usually decreasing functions of time since in most cases the resisting strength of structures decreases with time. Author

N65-34296# Maryland Univ., College Park. Dept. of Physics and Astronomy.

ARE ROOM TEMPERATURE SUPERCONDUCTORS A POSSIBILITY?

Richard A. Ferrell Feb. 1965 6 p refs Sponsored in part by AFOSR

(TR-439; AD-464850)

Experimental results are reported for a feasibility study to reduce temperature variations in the circulating heat transport fluid of space vehicle radiators. A control system was chosen where a fluid temperature drop below the set point closed the solenoid valve, while a temperature rise above the set point opened the valve. A cylindrical and a flat radiator configuration were fabricated and tested in a vacuum chamber. Results indicated that the control system is stable and applicable for a space vehicle with variable internal and/or external heat loads. Fluid outlet temperature oscillations, caused by changing radiator effectiveness, damped out in a few minutes. Heat load changes and the maximum heat rejection rate could be reduced by approximately 35 percent when one of the sections was shut off. G.G.

N65-34315# Bettis Atomic Power Lab., Pittsburgh, Pa.

RITZ DIFFERENCE EQUATIONS ON A TRIANGULATION

R. B. Kellogg Jan. 1965 10 p refs Presented at the 1965 Intern. Meeting on "The Appl. of Computing Methods to Reactor Probl.", Argonne, Ill., 17–19 May 1965

(Contract AT(11-1)-GEN-14)

(WAPD-T-1756; CONF-650501-5)

Ritz averaging method for the derivation of difference equations is discussed for the one group neutron diffusion equation. The results are obtained by first considering variational approximations from the point of view of functional analysis and proving convergence. The abstract theorem is then specialized to the boundary value problem. E.E.B.

N65-34328# California Inst. of Tech., Pasadena.

RESEARCH AND OTHER ACTIVITIES OF THE DIVISION OF ENGINEERING AND APPLIED SCIENCE Annual Report, 1963–1964

1964 147 p refs

Research reports are presented in the following subject areas: dynamics and celestial mechanics; fundamentals of fluid mechanics; supersonic and hypersonic flow; aeroelasticity; elasticity and viscoelasticity; fracture mechanics; structural analysis of solid rockets; structural dynamics; thin shell dynamics and stability; wave propagation; biorheology; cavitation; dynamics and vibrations; elasticity and wave propagation; general hydrodynamics; microhydrodynamics; nuclear engineering; basic research on analytical methods; human and insect vision; unit nervous organisms; earthquake and environmental health engineering; hydraulics and sediment transport; soil mechanics; structural analysis; communication and electromagnetic theory; magnetohydrodynamics and plasma physics; quantum electronics; solid state devices and physics; system theory and automatic control; materials science; and heat transfer and engineering design. R.R.D.

N65-34350# International Centre for Theoretical Physics: Trieste (Italy).
RELATIONS BETWEEN GREEN FUNCTIONS
C. G. Bollini and J. J. Giambiagi Apr. 1965 12 p refs Submitted for Publication
(IC/64/35) CFSTI: HC $1.00/MF $0.50

The familiar Green functions, as well as some relations between them are built up starting from a single function g(z), analytic in the z-plane with a cut running along the negative real axis, and such that $g^*(z) = g(z^*)$. Some spectral representations are discussed. Author

N65-34361# IIT Research Inst., Chicago, Ill.
MAGNETIC PROPERTIES OF INSULATORS Quarterly Progress Report, Feb. 16–May 15, 1965
Gordon A. Noble 5 Jun. 1965 26 p refs
(Contract AT(11-1)-587)
(IITRI-1184-17; COO-587-17)

A hole may be burned in the magnetic resonance spectrum of the F-center at 4° K. The experimental method of saturation at fixed field and frequency followed by field scan observation previously described is retained. However, 10^{-2} second saturation pulses are used. Under these conditions the observation shows a resonance with structure at suitable power levels. The difference between observation fields corresponding to maximum saturation is constant and independent of the ratio of saturating field and frequency. The optical emission band of F-centers in RbCl is described in terms of width, shape, and moments. The single effective frequency approximation is valid and the value of this parameter as determined from the temperature dependence of the width is close to that for absorption in the same samples. Other relationships between absorption and emission parameters are noted. The moments method yields a Huang-Rhys factor of 53 for emission in contrast to 28 for absorption although the band shapes are closely related. Definite impurity effects are noted in the width at 4° K. Author

N65-34365# California Inst. of Tech., Pasadena. Dept. of Engineering Science.
SHOCK WAVES FROM CAVITY COLLAPSE
Milton S. Plesset [1964] 7 p refs Presented at the Roy. Soc. Meeting on Deformation of Solids by the Impact of Liquids, London, May 1964

Experimental and theoretical research in the field of cavitation damage in solids is discussed. Experiments indicate that the duration of the stress pulse from a single bubble collapse is of the order of a microsecond. The shock, or pressure pulse which would be radiated when the collapse motion of a cavitation bubble is arrested, is considered as a possible source of cavitation damage. It is also suggested that jets could form during cavity collapse and that the damage would result from their impingement on the solid surface; however further experimental evidence is needed to confirm this theory. G.A.L.

N65-34406*# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
IMPROVED PARTICLE CHARGING TECHNIQUE Final Report
Frank Swanson, Paul Grinoch, and Anthony Favale Oct. 1964 125 p
(Contract NAS1-2309)
(NASA-CR-67135; RE-190) CFSTI: HC $4.00/MF $1.00 CSCL 20H

A high-current ion beam was utilized as a charging medium in conjunction with automatic electrostatic confinement of the microparticles during a charging process designed to impose unusually high electrical charges on microparticles so that they can be accelerated in a controllable electrostatic accelerator to hypervelocities. Experimental work on a radial confinement system is described, and a modification of the radial system to a plane confinement system is discussed. The concept of a pulsed system is presented and mechanical and electrical systems are described for a line confinement pulsed system. Two important criteria used as guidelines in the study are the development of a technique inherently compatible with the production of hypervelocity particles in per second or per minute availability, and the development of a system completely containable in the high voltage end of accelerators presently used for accelerating charged microparticles. L.S.

N65-34449# Stanford Univ., Calif. Dept. of Physics.
INVESTIGATION OF LIQUIDS AND SOLIDS AT LOW TEMPERATURES Final Report, Jan. 1, 1961–Mar. 31, 1965
W. A. Little Jun. 1965 6 p
(Contract Nonr-225(58))
(AD-618487)

Research being done on an electron scattering program for the study of the distribution of electric charge in deformed nuclei, and investigations of liquids and solids at low temperatures, are reported. A preliminary experiment was made on a polycrystalline sample of holmium at room temperature which indicated that the scattering of electrons from excited levels does not disturb the study of electric charge distribution in the nucleus. A description of the scattering method and apparatus is included. Low temperature studies emphasized the search for the existence of zero-sound in liquid helium (He^3). A theoretical analysis has shown that the existence of zero sound could be discerned from measurements of the scattering cross-section of X-rays as a function of temperature. G.A.L.

N65-34455# Naval Research Lab., Washington, D. C.
OPTICAL TECHNIQUES FOR ELECTRON PROBE ANALYSIS
J. Grosso 28 May 1965 13 p refs
(NRL-6290; AD-618372) CFSTI: $0.50

This study is concerned with two techniques in optical microscopy which exploit the principle of light interference to enhance optical contrast in metallurgical specimens. The first method achieves this through interference layers formed within the specimen by anodization in an electrolyte. A variety of experimental arrangements are suggested for carrying out the anodization. It is also noted that the optical effects of anodization can be adjusted by overlaying the specimen with films of nitrocellulose. The second method produces optical contrast through interference layers formed by replicating the etched-out surface of the specimen. This latter technique has the advantage of being applicable to any specimen which can be etched, and it is not limited to anodizable species. Here too, the optical results of replication can be adjusted by exposing the replica to the vapors of its solvent. Author

N65-34554# IIT Research Inst., Chicago, Ill. Dept. of Mechanics.
A DEFORMATION BOUNDING THEOREM FOR FLOW-LAW PLASTICITY
Philip G. Hodge, Jr. Jul. 1965 11 p ref
(Contract Nonr-1406(04))
(DOMIIT-1-28; AD-619910)

It is shown that the elastic principle of minimum complementary energy can be generalized to provide a bounding theorem for an elastic/perfectly-plastic material. For certain special classes of problems the bounding principle becomes a true minimum principle. Author

N65-34572# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
GENERAL THEORY OF OBSERVATION AND CONTROL
Final Report, 1 Jun. 1964–31 May 1965
Marcus C. Goodall 30 Jun. 1965 27 p refs
(Contract AF 19(628)-4147)
(AFCRL-65-503; AD-619949)

In Part 1 the basic concepts of observation and control are discussed in relation to available mathematical methods. It is pointed out that if quantum mechanics is taken as a model of observation and control, its known logical difficulties provide a potent test of the adequacy and power of a general theory. In Part 2 quantum theory is considered as a special case of observation and control characterized by a three-way symmetry (triality). This implies a revision of the theory of measurement and some definite consequences for the groups of continuous transformations admitted by the theory and their representations. In general, this may be regarded as a first step toward an adequate characterization of the role of the observer in a more general theory. Uncertainty is taken here to be essentially the same as undecidability for mathematical logic. If this is correct, then the methods of the two theories could be to some extent interchangeable. Author

N65-34685# California Univ., Berkeley. Inst. of Engineering Research.
A GENERAL THEORY OF A COSSERAT SURFACE
A. E. Green, P. M. Naghdi, and W. L. Wainwright Jun. 1965 52 p refs
(Contract Nonr-222(69))
(AM-65-5; AD-619945)

This paper is concerned with a general dynamical theory of a Cosserat surface, i.e., a deformable surface embedded in a Euclidean 3-space to every point of which a deformable vector is assigned. These deformable vectors, called directors, are not necessarily along the normals to the surface and possess the property that they remain invariant in length under rigid body motions. An elastic Cosserat surface and other special cases of the theory which bear directly on the classical theory of elastic shells are also discussed. Author

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N65-33657* Texas A&M Univ., College Station.
PRELIMINARY ENERGY BANDS OF GERMANIUM
D. R. Wiff *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 10 p refs (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

A discussion of a preliminary investigation leading to theoretical band calculations for germanium and silicon crystals is presented. The theory for a subroutine to calculate more accurately the starting values of the radial wave function, which are put initially into an augmented plane wave program, was worked out and the subroutine is being coded. New calculations are being started for Silicon because of the large energy gap between silicon (1.12eV) and germanium (0.74eV), to see if the new calculations will agree with experimental results and calculations by other methods. If this works, calculations for germanium can then be resumed. In addition a study of the augmented plane wave theory is being made to convert the existing programs to handle the diamond type lattice when two different types of atoms compose the crystal. Curves of potential energies for germanium are given. L.S.

N65-33658* Texas A&M Univ., College Station.
HYPERFINE STRUCTURE OF LITHIUM
D. L. Hardcastle *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 9 p refs (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

Differential equations needed to calculate the hyperfine structure of lithium are presented. A subprogram generating an initial set of wave functions that are used in starting the iterative process by which the differential equations are solved, and a subprogram that calculates all of the coefficients appearing in the differential equations are discussed. The wave function for the atom is constructed from space and spin parts. The space parts are constructed from three independent functions and the spin parts are constructed from two orthogonal one electron spin functions. The wave function for the atom is found by mixing the space and spin parts and requiring it to be antisymmetric in the interchange of any two particles, an eigenfunction of the total spin operator S^2, and an eigenfunction of the z component of the spin S_z. Using the resulting wave function and the variational principle three differential equations are found. By specifying the state of the atom the angular part of the integral can be carried out. Equations are given for the $1S^22S$ state. L.S.

N65-33664* Texas A&M Univ., College Station.
A STUDY OF CADMIUM ABSORPTION OF RESONANCE NEUTRONS IN VARIOUS FOIL MATERIALS
R. G. Cochran, J. E. Powell, and Robert T. Perry *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 15 p (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

Cadmium covered indium foils 2 cm in diameter with thickness varying from 2 mils to 8 mils were irradiated from a Pu-Be neutron source at distances varying from 0.25 inch to 3.25 inch, and the absorption of resonance neutrons in the foil materials were counted with a gamma scintillation spectrometer equipped with a sodium iodide well crystal. Photographs of the foil positioning device, the spectrometer, and the well crystal are shown. The data were plotted as a function of cadmium cover activity. The results of the determination of F_{cd}, a cadmium correction factor, are plotted as a function of foil thickness for various distances from the source. The curves indicate that substantial agreement was obtained between theory and experiment except near the source where the two deviate by approximately 4%. It is seen that F_{cd} is essentially independent of foil thickness in the region near the source but that it varies slightly with foil thickness as the distance between the source and detector increases. The results should be of assistance in making neutron flux measurements in arisotropic media such as nuclear reactor cores. L.S.

N65-33693# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EFFECT OF RADIATION ON CERTAIN CHARACTERISTICS OF ELECTRO LUMINESCENT SCREENS
L. M. Boyko 17 May 1965 7 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 6, no. 6, 1961 p 868–869
(FTD-TT-65-24/1+2; AD-467248)

The effects of various types of radiation on the electroluminescence of a glass screen with an electrolunophoric Zn/Cu layer was studied. This screen utilized a layer of graphite or silver as second electrode. Measurements showed that the

illumination brightness depended upon the applied sinusoidal voltage. Exposure to X-rays caused an increase in brightness that was more perceptible at low frequencies than at high frequencies. Exposure to gamma rays at low frequencies resulted in a sharp rise in brightness that became smaller with increased frequencies, and finally reached a turning point at 300 c. Further rises in frequency decreased brightness in comparison with the brightness of electro-luminescence in the absence of gamma radiation. The relative differences in electroluminescence during X-ray and gamma radiation at low frequencies can be used to obtain images of objects interposed between the screen and the radiation source. G.G.

N65-33709*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

OSCILLATOR STRENGTHS FOR THE N_2 SECOND POSITIVE AND N_2^+ FIRST NEGATIVE SYSTEMS FROM OBSERVATIONS OF SHOCK LAYERS ABOUT HYPERSONIC PROJECTILES

Victor H. Reis [1964] 25 p refs Submitted for Publication
(NASA-TM-X-51867) CFSTI: HC $1.00/MF $0.50 CSCL 20H

The electronic oscillator strengths, f, for the N_2 second positve and N_2^+ first negative systems were determined by measuring the radiation from the shock layer about a hypervelocity projectile with a time-of-flight scanning spectrometer. The measured values at the $\Delta v = 0$ bands were $f = 0.057 \pm 0.01$ for $N_2(2+)$ and $f = 0.053 \pm 0.01$ for $N_2(1-)$. The variation of f with wavelength for both systems was found to be similar to that previously reported by Nicholls. Author

N65-33715*# Harvard Coll. Observatory, Cambridge, Mass. Shock Tube Spectroscopy Lab.

SHOCK TUBE DETERMINATION OF AUTOIONIZATION LIFETIME AND OSCILLATOR STRENGTHS OF THE $3s^2\ 3p\ ^2p^o\text{-}3s3p^2\ ^2S_{1/2}$ DOUBLET OF Al I Scientific Report No. 2

W. R. S. Garton, W. H. Parkinson, and E. M. Reeves May 1964 29 p refs Submitted for Publication
(Grant NsG-438)
(NASA-CR-58144) CFSTI: HC $2.00/MF $0.50 CSCL 20H

The autoionization lifetime of the $^2S_{1/2}$ level and f-values of the $3s^2 3p\ ^2p^o\text{-}3s3p^2\ ^2S_{1/2}$ doublet of Al I have been measured by a shock-tube method. The lines of the doublet have a large natural width with a measured autoionization lifetime of 1.1×10^{-13} seconds. The f-values have been determined as 0.033 for the 1936 Å line and 0.049 for the 1932 Å line. Author

N65-33729# AVCO-Everett Research Lab., Everett, Mass.

SPIN-ORBIT COUPLING AND ELECTRON AFFINITY DETERMINATION FROM RADIATIVE CAPTURE OF ELECTRONS BY OXYGEN ATOMS

R. Stephen Berry, John C. Mackie (Univ. of Chicago), Raymond L. Taylor, and Robert Lynch Jul. 1965 29 p refs Submitted for Publication
(Contracts AF 29(601)-6488); DA-01-021-AMC-12005(Z); Proj. Defender)
(AVCO-Everett-RR-216; AD-468062)

The radiation continuum from the electron capture process $O^- + e \rightarrow O^- + h\nu$ is studied in the region of the threshold, 7800–8000 Å. The spectrum is produced in shock-heated vapors of potassium peroxide and rubidium oxide in neon and argon. Individual thresholds are resolved which corresponds to the transitions $O(^3P_2) \rightarrow O^-(^2P_{1/2})$, $O(^3P_2) \rightarrow (^2P_{3/2})$, $O(^3P_1) \rightarrow O^-(^2P_{3/2})$ and possibly $O(^3P_0) \rightarrow O^-(^2P_{1/2})$. From these threshold measurements, the electron affinity of the oxygen atom is determined to be 1.478 ± 0.002 eV and the separation of $^2P_{1/2}$, $^2P_{3/2}$ states of O^- is 285 ± 15 cm^{-1} corresponding to a spin-orbit coupling constant of 190 ± 10 cm^{-1} for the oxygen negative atomic ion. Author

N65-33736# California Univ., Berkeley. Electronics Research Lab.

OPTICAL LEVEL POPULATION INVERSIONS IN A SODIUM-MERCURY MIXTURE DISCHARGE Research Report

L. H. Lin 4 Jun. 1965 55 p refs *Its* Rept.-65-15
(Grants DA-ARO(D)-31-124-G317; AF-AFOSR-139-64)
(AROD-3323-7; AD-469266)

Population densities of excited sodium levels in a glow discharge of a mixture of sodium and mercury vapors were obtained by spectral line intensity measurements. Comparison with the case of pure sodium vapor discharge was made. It was found, in the mixture discharge, that the population densities of sodium levels, which have energies close to the energies of mercury 6^3P_1 and 6^3P_0 levels, are highly populated by the process of resonance excitation transfer to the extent that many population inversions result between these levels and some lower off-resonance levels. The excitation transfer between the mercury metastable level 6^3P_0 and the sodium level $7^2S_{1/2}$ is most significant; the corresponding cross section is estimated to be 4.7×10^{-15} cm^2. Optically allowed transitions between the population inverted levels are in the infrared region, the shortest wavelength being approximately 3.37 μ ($7^2S_{1/2} \rightarrow 5^2P_{1/2, 3/2}$). The negative absorption coefficients for some important transitions are also calculated. Author

N65-33780# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. for Theoretical Physics.

ASYMPTOTIC RELATIONS OF THE PION PRODUCTION CROSS SECTIONS IN NEUTRINO–NUCLEON INTERACTION [ASIMPTOTICHESKIE SOOTVOSHENYA DLYA SECHENII ROSHDENIYA PIONA V NEITRONNO–NUKLONNOM VZAIMODEISTVII]

Nguyen Van Hieu and Pham Qui Ty 1965 8 p refs In RUSSIAN Submitted for Publication
(JINR-P-2062) CFSTI: HC $1.00/MF $0.50

Dispersion equations are used to prove asymptotic parity of interacting particles, and asymptotic relations of pion production cross sections in neutrino–nucleon interactions are shown. Particle scattering and isotropic structures are considered. Transl. by M.W.R.

N65-33785# Argonne National Lab., Ill.

WATER ENRICHED EMULSIONS FOR THE SCINTILLATION COUNTING OF AQUEOUS SOLUTIONS OF β-EMITTERS

Gerhard Erdtmann and Gunter Herrman (Mainz Univ., W. Germany) Apr. 1965 10 p refs Transl. into ENGLISH from Radiochim. Acta (Frankfurt am Main), no. 1, 1963 p 98–103
(ANL-TRANS-183)

Equal volumes of aqueous solutions and toluene-scintillator—composed of toluene, PPO and POPOP—from stable emulsions if highly dispersed silicon dioxide and an emulsifying agent are added. Acid concentration of the aqueous phase should not exceed 3 N, that of base 0.1 N. Highly concentrated solutions of salts may be emulsified with a dioxane-ethanol-xylene-scintillator and the silica. Maximum counting efficiencies in 20 ml samples containing 50% v/v of aqueous solution are nearly 100% for β-emitters of medium or high energy. ^{14}C (160keV) and ^3H (18keV) are counted with an efficiency of 40 and 0.35%, respectively. Counting errors compare with those expected from radioactive decay, except if low energy β-radiation is counted. In this case preparation causes an additional error of about ±3% (standard deviation). Becaus

of the high counting efficiency and the large sample volume, the emulsions are superior to other liquid counting methods, especially in low level counting. However, low energy β-emitters such as tritium are preferentially counted in homogenous liquid scintillators. Author

N65-33786# California Inst. of Tech., Pasadena.
SERIES OF HADRON ENERGY LEVELS AS REPRESENTATIONS OF NON-COMPACT GROUPS
Yossef Dothan, Murray Gell-mann, and Yuval Ne'eman May 1965 8 p refs
(Contract AT(11-1)-68)
(CALT-68-38)

The use of a non-compact algebra that preserves the state of rest for each hadron level (stable or unstable), and approximately connects together the members of an idealized infinite sequence of such levels, is discussed. Considered are possibilities of bringing in reverse parity states by using the whole compact algebra as a very approximate symmetry of the stationary and quasi-stationary states, and also schemes characterized by discarding the negative parity elements of the compact algebra as good symmetries of the stationary and quasi-stationary states of the hadrons at rest. G.G.

N65-33812*# Consultants and Designers, Inc., Arlington, Va.
MEASUREMENTS OF LOW ENERGY PARTICLE FLUXES ON SATELLITES "COSMOS" AND "ELECTRON" [IZMERENIYA POTOKOV CHASTITS MALYKH ENERGIY NA SPUTNIKAKH "KOSMOS" I "ELEKTRON"]
S. N. Vernov, V. V. Mel'nikov, I. A. Savenko, and B. I. Savin 30 May 1965 13 p refs Transl. into ENGLISH from RUSSIAN Presented at COSPAR 5th Space Sci. Symp., Buenos Aires, May 1965
(Contract NAS5-3760)
(NASA-TT-F-9683) CFSTI: HC $1.00/MF $0.50 CSCL 20H

This paper deals mainly with measurements of particle fluxes with energies 0.1 to 10 kev, conducted with the aid of spherical electrostatic analyzers placed aboard "Electron-2" The data considered cover the period from 30 January through 21 February 1964. Presented here also are the general results of short-term experiments carried out on the satellites "Cosmos-12" and "Cosmos-15". A description is given of the apparatus, identical for both types of satellites. The general conclusion derives from measurements of ions during the period consists in that the total flux of ions in the said energy range does not exceed, inside the magnetosphere, the devices' response threshold, that is, $5 \cdot 10^7$ ion/cm^2 sec., result which agrees well with those of Explorers 10, 12 and 18 inside the magnetosphere. Author

N65-33820*# Consultants and Designers, Inc., Arlington, Va.
MAGNETIC BREMMSTRAHLUNG IN A VARIABLE FIELD AS THE MECHANISM BEHIND THE CHANGING RADIANCE OF QUASISTELLAR RADIO SOURCES [MAGNITOTORMOZYOYE IZLUCHENIYE V PEREMENNOM POLE KAK MEKHANIZM MENYAYUSHCHEYSYA SVETIMOSTI KVAZIZVEZDNYKH RADIOISTOCHNIKOV]
L. M. Ozernoy 13 Aug. 1965 10 p refs Transl. into ENGLISH from Astron., Dokl. Akad. Nauk SSSR (USSR), v. 163, no. 1, 1965 p 54–57
(Contract NAS5-3760)
(NASA-TT-F-9694; ST-OA-PF-10371) CFSTI: HC $1.00/MF $0.50 CSCL 20H

This paper draws particular attention to the variable radiance mechanism of quasi-stellar radio sources within the framework of the magnetic bremmstrahlung nature of their radiation. The author concludes that the radiance periodicity may constitute an indicator of the variations of radio sources magnetic fields, due to inner processes in central regions. Author

N65-33824*# Consultants and Designers, Inc., Arlington, Va.
MEASUREMENT BY γ-SPECTROMETRY OF THE RADIOACTIVITY OF THE GRANES METEORITE FALLEN ON 13 NOVEMBER 1964 [LA RADIOACTIVITE DE LA METEORITE GRANES (CHUTE DU 13 NOVEMBRE 1964) MESUREE PAR SPECTROMETRIE γ]
Daniel Nordemann, Jacques Tobailem, and Michele Schneizer 24 Sep. 1965 5 p refs Transl. into ENGLISH from Comp. Rend. Acad. Sci., Meteorites (Paris), v. 260, 21 Jun. 1965 p 6664–6666
(Contract NAS5-3760)
(NASA-TT-F-9902; ST-CC-10390) CFSTI: HC $1.00/MF $0.50 CSCL 18H

The activities of the γ-emitters, present in a 1.186 kg sample of the Granes (Aude) stone meteorite, have been determined by quantitative γ-spectrometry of weak proper motion. Author

N65-33896# RAND Corp., Santa Monica, Calif.
DIFFUSION WITH "COLLISIONS" BETWEEN PARTICLES
T. E. Harris Jul. 1965 32 p refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-4367-PR; AD-618499)

Two or more particles duffuse on the same line. Each moves independently of the others according to the Brownian movement (Wiener process) except when collisions occur. An assumption is made about what happens at collisions. It is shown that if initially the particles are sprinkled on the line according to a Poisson process with rate 1, then the displacement of a single particle, for large time, has approximately a Gaussian distribution with standard deviation $(2t/\pi)^{1/4}$, rather than $t^{1/2}$ as in the case of an unimpeded particle. Author

N65-33913# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Electronics.
OBSERVATION OF SUPERPARAMAGNETISM BY THE MOSSBAUER EFFECT
S. Shtrikman, D. Treves, and W. J. Schuele (Franklin Inst., Philadelphia) 15 Nov. 1964 14 p refs
(Contract AF 61(052)-654)
(TN-13; AD-615589) CFSTI: HC $1.00/MF $0.50

Mossbauer spectra of Fe^{57} in ultrafine $NiFe_2O_4$ and $CoFe_2O_4$ powders were studied, as a function of crystallite size and temperature. The hyperfine field was found to collapse at a temperature, lower than the Curie points which decreases with particle size. This collapse of the hyperfine field is interpreted as motional narrowing due to the onset of superparamagnetism. Author

N65-33927# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.
STRENGTH FUNCTIONS OF U-235 FOR NEUTRONS WITH L = 0 AND 1
Yu. V. Ryabov and Yu. I. Fenin 1965 6 p refs In RUSSIAN (JINR-P-2068) CFSTI: HC $1.00/MF $0.50

The strength functions for S and P neutrons were calculated from an analysis of the average of the summed cross sections for fission and radiative capture. An electronic computer was used. The values for the strength functions were found to be $S_0 = 0.91 \pm 0.03 \times 10^{-4}$ and $S_1 = 2.8 \pm 0.4 \times 10^{-4}$. Author

N65-33929# Los Alamos Scientific Lab., N. Mex.
STUDY OF THE ELECTRONIC STRUCTURE OF THE CARBIDES OF THORIUM, URANIUM AND PLUTONIUM

P. Costa and R. Lallemont [1964] 8 p refs Transl. into ENGLISH from J. Phys. Chem. Solids, v. 25, 1964 p 559–564 (LA-TR-64-29)

Within the framework of studies on the electronic structure and physical properties of cubic face-centered carbides of the NaCl type, the resistivity and thermoelectric power of thorium-, uranium-, and plutonium-monocarbides were measured in a temperature range of 4° K. to 1200° K. It was found that ThC becomes a superconductor at about 9° K, and that PuC undergoes a magnetic type transformation at about 100° K. Analyses of the resistivities and the thermoelectric powers indicated that the band structure of these carbides must include a narrow band. It is suggested that ThC should be similar to a transition metal carbide with a narrow d-band, that UC should show a mixed d-f band, and that PuC should be analogous to a rare earth carbide with well localized f-electrons. S.C.W.

N65-33940# Nihon Univ., Tokyo (Japan). Coll. of Science and Engineering.

MAGNETIC MOMENTS OF BARYONS AND FUNDAMENTAL TRIPLET

Shin Ishida, Jun Otokozawa, and Hajime Shimodaira [1965] 14 p refs

(NUP-65-9) CFSTI: HC $1.00/MF $0.50

The electromagnetic form factors of octet baryons are investigated from the stand-point that the baryons are three-body composite system of fundamental triplet. At first we can show that the magnetic moments of fundamental triplet are proportional to its charge and the magnitude is comprehensible as due to the effects of meson cloud. Then we get the satisfactory results on the magnetic moments of the baryons, provided that they are produced by the magnetic moment of each constituent triplet. Further we obtain the following relations on the form factors of the nucleon: $G_{M,p}/\mu_p = G_{M,n}/\mu_n = G_{E,n} = 0$. Author

N65-33949# Gt. Brit. Ministry of Aviation, Nottingham. Technical Information and Library Services.

NATURE OF PARAMAGNETIC RESONANCE IN MOLECULAR CRYSTALS OF MAGNESIUM PHTHALOCYANINE [O PRIRODE PARAMAGNITNYKH TSENTROV V MOLEKULARNYKH KRISTALLAKH FTALOTSIANIDA MAGNIYA]

1965 7 p refs Transl. into ENGLISH from Zh. Struct. Khim. (USSR), v. 5, no. 5, 1964 p 697–701

(TIL/T-5596) CFSTI: HC $1.00/MF $0.50

The amorphous and crystalline modification of magnesium phthalocyanine repeatedly sublimed in vacuo exhibit a weak electronic paramagnetic resonance (EPR) which corresponds to one unpaired electron in 10^5 molecules. The signal is caused, evidently, by the separation of charges in the defects of the solid. With the interaction of oxygen with the amorphous modification at room temperature, a sharp increase in intensity of the EPR signal is observed. At high temperatures, the same increase in intensity of the EPR signal is also observed for the crystalline modification. The number of bound molecules of oxygen corresponds to the number of paramagnetic centres which arise. The supposition that the oxygen forms a complex with the magnesium phthalocyanine with transfer of charge is advanced. Author

N65-33953*# National Aeronautics and Space Administration, Washington, D. C.

VARIATIONAL PRINCIPLES IN THE COLLISION THEORY

Yu. N. Demkov Sep. 1965 180 p refs Transl. into ENGLISH of the book "Variatsionnyye Printsipy V Teori: Stolknoveniy" Moscow, Gos. Izd. Fiz.-Mat. Lit., 1958

(NASA-TT-F-9533) CFSTI: HC $5.00/MF $1.00 CSCL 20H

The application of variational principles in quantum mechanics is reviewed. The variational principle for various problems in collision theory, a general problem on elastic scattering of particles by a force field, and elastic and inelastic collisions for the problem of many bodies are formulated. Problems are discussed on broadening the class of permissible variations to substantiate applying the variation principle to those cases where the wave functions of the colliding particles are only approximately known. A relation between various formulations of the variational principle is established. The relation of the variational principle with the excitation theory using the Born method, the method of wave excitation, the method of a self-adjusted field, etc., are discussed, and results obtained using variational methods for electron scattering on hydrogen are analyzed. The existence of an infinitive succession of variational principles is proven. Those general properties which should be satisfied by the amplitude of scattering and effective cross section are discussed. Formulae analogous to the virial theorem for problems of scattering are derived for various cases by scale variation. R.N.A.

N65-34016# Lockheed Missiles and Space Co., Sunnyvale, Calif.

OPACITY OF HIGH-TEMPERATURE AIR Technical Report, 15 Jan. 1962–15 Nov. 1964

B. H. Armstrong, R. R. Johnston, and P. S. Kelly Kirtland AFB, N. Mex., AF Weapons Lab., Jun. 1965 312 p refs *Its* Rept.-8-04-64-2

(Contract AF 29(601)-5006)

(AFWL-TR-65-17; AD-618399)

A new calculation of the opacity high-temperature air (kT = 1 –20 eV) is carried out. Line (bound-bound) transitions are included and LS term splitting of configurations is accounted for in the n = 2 and 3 levels. The primary purpose of the calculation is to remove the hydrogenic approximation to the dominant photoelectric and line transitions. In place of the hydrogenic approximation, Hartree-Fock-Slater matrix elements are used for the line transitions. For the photoelectric transitions, a combination of the Burgess-Seaton extension of the Coulomb approximation, and a high-energy acceleration-matrix-element Born approximation is employed. Comparisons are carried out with experiment and with previous calculations. A review and discussion is presented of the statistical mechanics of ionized gases, and some new results pertinent to the calculation of occupation numbers are presented. Author

N65-34023# Rochester Univ., N. Y. Dept. of Physics and Astronomy.

EVIDENCE FOR PARITY—SU_3 MIXING IN THE MESON NONETS

R. E. Marshak, S. Okubo, and J. Wojtaszek 26 Jul. 1965 12 p refs

(Contract AT(30-1)-875)

(UR-875-91)

Recent experimental evidence for a $J = 0^+$ meson at about 700 Mev, together with evidence for the existence of positive parity mesons of higher spin ($J = 1^+, 2^+$) were used in calculations on higher symmetry groups in the meson nonets, wherein mixing of the SU_3 octets and singlets is allowed. Mass predictions for the J = 1 and J = 2 mesons were derived from the known three masses for the $J = 1^-$ and $J = 2^+$ nonets; and experimental and predicted values for the η-type and K'-type particles are shown in a table. G.G.

N65-34037# California Univ., La Jolla. Inst. for Radiation Physics and Aerodynamics.

MOLECULAR COLLISION CROSS SECTIONS AND THE EFFECT OF HYDROGEN ON VIBRATIONAL RELAXATION IN CARBON DIOXIDE

R. Marriott [1965] 25 p refs Sponsored in part by ARPA

(AROD-5133-2; AD-464889)

A numerical method previously employed for the calculation of vibrational excitation cross sections and vibrational relaxation in CO_2 was applied to the case of vibrational excitation of CO_2 by collision with molecular hydrogen. Cross sections were calculated for collision energies up to 2.5 eV, and coupling between five molecular states, distributed between the three vibrational modes was retained. The dependence of vibrational relaxation in CO_2 on H_2 concentration has been determined in terms of these cross sections for temperatures from 300 to 600. The results are in qualitative agreement with the second absorption measurements of Winter (1963) and the experimental observation that H_2 appears less efficient at 400K at inducing vibrational transitions in CO_2 than at 300K. It is concluded that such anomalous behaviour can be accounted for when proper allowance is made for the coupling between the molecular vibrational states. Author

N65-34051# Reed Research, Inc., Washington, D. C.

THE SPHERE THEOREM IN POTENTIAL THEORY

J. Martinek, G. C. K. Yeh, and G. S. S. Ludford (Maryland Univ., College Park) [1953] 7 p refs

(Contract Nonr-1445(00))

(AD-617000)

The sphere theorem in potential theory is investigated. A proof of a sphere theorem similar to that of Weiss is presented along with three examples of the application of this theorem in the determination of the image system of a given distribution. Immediate generalizations of both the interior and exterior sphere, and circle theorems are briefly considered. G.A.L.

N65-34086# Instituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina).

PHENOMENOLOGICAL AND MICROSCOPIC ANALYSIS OF PROPERTIES OF EVEN-EVEN NUCLEI: PART A: PHENOMENOLOGICAL MODELS

C. A. Heras, S. M. Abecasis and H. E. Bosch (La Plata Univ.) Mar. 1965 128 p refs

(Grant DA-ARO-49-092-65-G35)

(LR-7; AD-617942) CFSTI: HC $4.00/MF $1.00

Two special forms of the unified model have been considered: 1) The *vibrational model* in which only surface collective oscillations are considered. 2) *The rotational model* in which the nuclear shape is taken as fixed, so that rotations are the only collective motions allowed. The rotational or strong coupling model has proved very successful in the interpretation of properties of nuclei in the mass regions $19 < A < 25$; $150 < A < 190$, and $A > 226$. This article will deal with the fundamental assumptions of the unified and Davydov models together with their refinements and extensions. The microscopic models based on those ideas are described with some detail. The excited states of even-even nuclei show certain regularities, allowing to distinguish different "types" of spectra (Ma4, Sh1) characterized by the energy ratios between the excited levels and the character of these levels. The following types of spectra are mentioned: a) Spectra characterized by ratios of energy of excited states and character of excited states corresponding to closed proton and/or neutron shells. b) Spectra in which the character of the first excited state is 2+. d) Spectra that exhibit relatively low-lying negative parity states. Author

N65-34197# Rochester Univ., N. Y. Dept. of Physics and Astronomy.

THE STRANGENESS CHANGING AXIAL VECTOR COUPLING CONSTANT

L. K. Pandit and J. Schechter 6 Aug. 1965 11 p refs Submitted for Publication

(Contract AT(30-1)-875)

(UR-875-93)

A sum rule technique is applied to the strangeness changing axial vector weak current. Cabibbo's factor of $\sin\theta$ in the effective weak current is considered present in the original current since it cannot be explained as a renormalization effect. Values obtained for the axial vector coupling constant are in reasonable agreement with Cabibbo's theory. Associated charges of the octets of the weak vector and pseudovector currents are defined in the usual manner, and it is emphasized that SU(3) invariance is not assumed. The weak interaction Hamiltonian is essentially that of Cabibbo, but it is not necessary to specify the D/F ratio of the matrix elements of the currents. The strong interaction Yukawa Hamiltonian is defined with the aid of SU(3) symmetry. The strangeness-axial vector currents formula is obtained by evaluating the commutation relation equation between proton states and separating the contributions from the intermediate one-particle Λ and Σ_0 states. Values are compared with those obtained if the pole contributions to the sum rule is neglected. M.W.R.

N65-34224*# National Aeronautics and Space Administration. Gooddard Space Flight Center, Greenbelt, Md.

ELECTRON CAPTURE BY PROTONS IN HYDROGEN IN AN ELECTRIC FIELD

Kazem Omidvar Jul. 1965 28 p refs Submitted for Publication

(NASA-TM-X-55289; X-641-65-306) CFSTI: HC $2.00/MF $0.50 CSCL 20H

A simple closed formula for the electron capture cross section in parabolic coordinates, appropriate to the charge transfer in an electric field, is derived with the electron initially and finally in two arbitrary sublevels of the atom. It is shown that the cross section, apart from a weighting factor, is independent of the particular sublevel and depends only on the principal quantum numbers involved. In this way the charge transfer cross section in an electric field is obtained. In addition, the solution of the problem in parabolic coordinates leads, through a transformation, to the determination in closed form of the cross section in spherical coordinates. It is found that the momentum distribution of electrons in the Stark levels of the hydrogen have extremely simple form in contrast to the momentum distribution in the optical levels. The averaged momentum distribution over the sublevels of a principal quantum number gives results identical to the results originally obtained. The classical momentum distribution of a bound particle in a Coulomb field is shown to be the same in form as the quantum mechanical distribution. The use of this distribution function in classical calculation of scattering will make the classical and the quantum mechanical calculations more consistent Author

N65-34273# Oak Ridge National Lab., Tenn. Metals and Ceramic Div.

CONVERGENCE IN ONE-CENTER EXPANSIONS: H_2^+

Hubert W. Joy and George S. Handler (Calif. Univ., La Jolla) [1965] 11 p Presented at Conf. in Honor of R. Mulliken, Sanibel Island, Fla., Jan. 1965

(AROD-5133-4; AD-464275)

The inter- and intra-shell convergence in one-center expansions of $H(2^+)$ for the ground state, and the first excited state, were examined theoretically. Analogous convergence

data for the ground state and the first excited state of the molecule were deduced and are presented in tables. G.G.

N65-34304# International Center for Theoretical Physics, Trieste (Italy).
THE FROISSART–GRIBOV CONTINUATION AND REGGEON UNITARITY CONDITIONS
J. C. Polkinghorne (Cambridge Univ.) Apr. 1965 14 p refs Submitted for Publication
(IC-65-41) CFSTI: HC $1.00/MF $0.50

In terms of the proper time of the particle a covariant Hamiltonian formulation (for the free-particle case) of Dirac's electron theory is given, and the problem of Zitterbewegung is discussed as an example. Author

N65-34305# International Center for Theoretical Physics, Trieste (Italy).
PROPER TIME FORMULATION OF THE FREE-ELECTRON THEORY
I. Saavedra (Univ. de Chile, Santiago) Apr. 1965 13 p refs Submitted for Publication
(IC-65-40) CFSTI: HC $1.00/MF $0.50

An identity is derived which is useful in the discussion of unitary integrals. It is used to discuss single Regge pole insertions in the Froissart-Gribov continuation and with the help of perturbation theory models a derivation is given on Reggeon unitarity conditions. The general form suggested by Gribov, Pomeranchuk and Ter-Martirosyan is confirmed. Finally cancellation mechanisms are discussed and their relation to the mechanism generating Regge poles is emphasized. Author

N65-34329# Los Alamos Scientific Lab., N. Mex.
FISSION FRAGMENT REMOVAL OF URANIUM FROM A FISSIONING SURFACE
P. J. Peterson and M. M. Thrope 10 Sep. 1965 22 p refs
(Contract W-7405-ENG-36)
(LA-3352-MS) CFSTI: $2.00

A model is proposed whereby U is removed from a fissioning U metal source by deposition of fission fragment energy in UO_2 crystallites of a critical size range on the source surface. It is also suggested that a second method of U removal is also operative. This concept is represented by the equation

$$M' = M_o (1 - e^{-\lambda'(\Phi t)}) + c'(\Phi t),$$

where M' is micrograms of U removed, M_o is micrograms of U originally present in UO_2 crystallites of a certain size, λ' is a calculated removal constant for UO_2 crystallites of a given size, and Φt is the integrated thermal neutron flux seen by the source. The term c' (Φt) represents the second method of removal where the amount removed per unit of Φt is the constant, c'. This curve is fitted to data gathered in a series of irradiation capsule experiments. Author

N65-34351# International Centre for Theoretical Physics, Trieste (Italy).
DYNAMICAL GROUPS AS GROUPS OF MOTIONS OF RIEMANNIAN SPACES
R. Raczka Mar. 1965 6 p refs Submitted for Publication
(IC/65/32) CFSTI: HC $1.00/MF $0.50

The consequences of the hypothesis that the geometry of an interaction region of elementary particles is a Riemannian geometry are analyzed. The considerations of the energy spectrum of scalar particles lead in a natural way to the Gell-Mann-Okubo mass formula. Author

N65-34352# Joint Inst. for Nuclear Research, Dubna (USSR)
EXPERIMENTAL DETERMINATION OF THE DISTRIBUTION OF LOCAL ENERGY LOSSES (LEL) AND OF THE QUALITY FACTOR OF IONIZING RADIATION
V. N. Lebedev 1965 10 p refs
(JINR-P-2069) CFSTI: HC $1.00/MF $0.50

Questions connected with the experimental determination of local energy losses (LEL) can be divided into two groups. The first group is concerned with the practical determination of radiation hazards resulting from emissions from unknown compounds. Here, as a rule, there is a quick determination of averages for the whole LEL spectrum and of the quality factors of the emissions. Recombination methods will give accurate solutions to such problems. The second group of questions deals with biological effects of emissions for various LEL'S and revisions of the necessary correlations of the quality factors of these losses. Energy distributions must be known for these solutions; and, since recombination methods do not provide the necessary accuracy, the method of Rossi and Rosenzweig is recommended. Transl. by M.W.R.

N65-34360# California Univ., Berkeley Lawrence Radiation Lab.
ELASTIC SCATTERING OF STRONGLY ABSORBED IONS
Evangelos Hadjimichael (Ph.D. Thesis) 8 Apr. 1965 58 p refs
(Contract W-7405-ENG-48)
(UCRL-11781)

The interaction radius R and the nuclear surface thickness ΔR of several nuclei have been investigated by phase-shift analysis of elastically scattered strongly absorbed ions. A diffraction model is used to account for physical arguments that suggest a particular functional form for the nuclear phase shift and the partial-wave scattering amplitude as functions of the angular momentum. The elastic scattering of C^{12} and O^{16} ions has been measured as a function of angle by using the Berkeley heavy-ion linear accelerator. Existing data were analyzed on elastic scattering of a particles, He^3 ions, and deuterons at several energies. Unambiguous parameters were obtained from which the nuclear radius $R_n \approx r_s A^{1/3}$ and the nuclear surface thickness ΔR were calculated. It was found that ΔR 1.6×10^{-13} cm and the radius parameter $r_s \approx 1.39 \times 10^{-13}$ cm. The total reaction cross sections were also calculated. A comparison with results obtained by other methods is presented. The versatility and validity of the present model in the region of relativistic energies is demonstrated by its successful application to the π^-p elastic scattering at 2.01 BeV. Author

N65-34362# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
CALCULATION OF THE BUILDUP OF CADMIUM DUE TO THE NEUTRON IRRADIATION OF SILVER
Dario Bollacasa and D. T. Goldman 15 Feb. 1965 9 p refs
(Contract W-31-109-ENG-52)
(KAPL-M-6455)

The buildup of cadmium isotopes following the irradiation of elemental silver is calculated for several values of thermal neutron flux. Two digital computer programs are used; one to calculate the flux weighted capture probability, and the other to perform the depletion and buildup analysis. Sufficient detail is presented to enable the reader to modify the input quantities to suit a particular reactor configuration. Author

N65-34369 European Organization for Nuclear Research, Geneva (Switzerland).

PARTICLE SEPARATION BASED ON THE IDENTIFICATION BY A DISC [SEPARATEUR DE PARTICULES BASE SUR L'IDENTIFICATION PAR UN DISC]

R. Meunier, M. Spighel, J. P. Stroot, and P. Duteil 13 Jul. 1965 15 p refs In FRENCH; ENGLISH summary
(CERN-65-27) CFSTI: HC $1.00/MF $0.50

An alternative method is presented for the electrostatic separation of high energy particles. It is based upon identification of the particles by means of a Cerenkov counter (DISC) and separation by means of pulsed electric deflexion. The advantages of this method include: simultaneous separation, nondependence upon the nature of the particles, and separation precision. A description of the method and apparatus is included.
Transl. by G.A.L.

N65-34385# European Organization for Nuclear Research, Geneva (Switzerland). Div. of Nuclear Physics.

RECONSTITUTION OF RECTILINEAR TRACKS IN A SPARK CHAMBER WITH TRANSPARENT ELECTRODES [RECONSTITUTION DE TRACES RECTILIGNES DANS UNE CHAMBRE A ETINCELLES A ELECTRODES TRANSPARENTES]

V. Chabaud and F. Plouin 1965 29 p refs In FRENCH
(CERN-65-15) CFSTI: HC $2.00/MF $0.50

A spark chamber is described in which the electrodes consist of a wire mesh fine enough to be essentially transparent. When the classical spark chamber is used for photographic delineation of traces, pictures must be taken from two separate points of view. The transparency of the electrodes in this new model, however, requires only a single exposure.
Transl. by J.M.D.

N65-34388# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

THE EFFECT OF RESONANCE ON A DIRECT PROCESS

A. Pfitzner and C. Riedel Mar. 1965 15 p refs Repr. from Nucl. Phys., v. 60, no. 4, 1964 p 672–685
(AERE-TRANS-1025) CFSTI: HC $1.00/MF $0.50

A direct process is specified here, as a process proceeding by the direct participation of only one nucleon of the target, the so-called active nucleon. This process is described by the component of the total wave function in the subspace of the one-particle excitations of the target. By the use of suitable projection operators, the matrix element in the "single-resonance approximation" is constructed. Apart from the usual direct term a "resonance direct" term is obtained. In this extension of the direct reaction mechanism, an appreciable energy dependence of the angular distribution is possible. This is demonstrated by a simplified test calculation for the reaction $C^{13}(p,p')$ in the energy range 3.42 MeV $\leq E_p \leq$ 3.62 MeV.
Author

N65-34400*# Wisconsin Univ., Madison. Theoretical Chemistry Inst.

SUDDEN APPROXIMATION APPLIED TO ROTATIONAL EXCITATION OF MOLECULES BY ATOMS. II: SCATTERING OF POLAR DIATOMICS

R. B. Bernstein and K. H. Kramer 13 Jul. 1965 73 p refs (Grant NsG-275-62; Contract NOw-62-0604-c)
(NASA-CR-67042; WIS-TCI-91) CFSTI: HC $3.00/MF $0.75 CSCL 20H

The sudden approximation is applied to the computation of rotational transition probabilities and inelastic total cross sections for the scattering of polar and non-polar diatomic molecules (rigid motors) by atoms. The calculations are based upon an interaction potential which includes both short- and long-range anisotropies. At thermal energies the long-range attractive parts of the potential are of principal importance in determining the inelasticity, with the main contribution arising mining the inelasticity, with the main contribution arising from the quadrupole interaction term (varying as $R^{-7}\cos^3\theta$). The computations show the rapid onset of "dominant-coupling" behavior (randomization of transition probability among all close-coupled states) for impact parameters below about $(S/\pi)^{1/2}$, where S is the total inelastic total cross section.
Author

N65-34438*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MEASUREMENTS OF BREMSSTRAHLUNG PRODUCED BY 0.75 AND 1.25 MEV ELECTRONS INCIDENT ON TYPICAL APOLLO WALL SECTIONS

Herbert D. Hendricks, Thomas G. James, and Larry B. York (NASA. Manned Spacecraft Center, Houston, Tex.) Washington, NASA, Sep. 1965 29 p refs
(NASA-TM-X-1140) CFSTI: HC $2.00/MF $0.50 CSCL 20H

Typical Apollo wall sections were irradiated with 0.75 and 1.25 MeV electrons from an electron accelerator. The intensity and angular distribution of the bremsstrahlung produced in and attenuated by the wall sections were measured. The maximum dose rates are received through the thinnest wall sections. The maximum dose rate and bremsstrahlung intensity from all wall sections are always greatest in the direction of the electron beam and decreases sharply on each side of the beam. Bremsstrahlung spectra show a maximum photon intensity at energies between 80 and 115 keV and a greater intensity of high-energy bremsstrahlung photons from 1.25 MeV electrons than from 0.75 MeV electrons.
Author

N65-34446# Los Alamos Scientific Lab., N. Mex.

THE NON-EQUILIBRIUM DIFFUSION EQUATION

B. E. Freeman 17 Sep. 1965 20 p refs
(Contract W-7405-ENG-36)
(LA-3377) CFSTI: $1.00

The system of equations describing the diffusion of radiation through material is discussed from the point of view of the formulation for numerical solution. These equations, which are more general than the equilibrium diffusion equation, contain terms describing (a) cooling of material by radiation in optically thin systems, (b) diffusion of radiation through material with or without energy exchange with the material, and (c) an approximation to the free streaming of radiation. Consequently, they are applicable to a much wider range of radiation transport phenomena than the equilibrium diffusion equation. The several regions of applicability are examined from the point of view of the structure of the equations and the frequency dependence. Finally, the general nonequilibrium diffusion equations are discussed regarding appropriate mean absorption coefficients for frequency groups. Spatial and time dependences of the difference equations are also considered.
Author

N65-34457# California Univ., Berkeley. Lawrence Radiation Lab.

BEVATRON OPERATION AND DEVELOPMENT, 44, OCT.–DEC. 1964

Robert W. Allison, Jr., Kenneth C. Crebbin, William L. Everette, Fred H. G. Lothrop, and Emery Zajec 23 Jun. 1965 22 p refs
(Contract W-7405-ENG-48)
(UCRL-16203) CFSTI: $1.00

The Bevatron provided beam for physics research 85% of the scheduled operating time. The only shutdowns this quarter were during the normal weekly maintenance periods and the Thanksgiving and Christmas-New Year holiday periods. Most of the Bevatron study periods were devoted to injection and

alignment studies of the injection system. A new beam-spilling device using feedback from the beam-induction-electrode system to control the rf voltage was put into operation. One experiment continued through this quarter and four new experiments were started this quarter. Author

N65-34508*# National Aeronautics and Space Administration, Washington, D. C.
ENERGY EXCHANGE IN THE COLLISION OF PARTICLES WITH A SOLID WALL
V. B. Leonas Oct. 1965 10 p refs Transl. into ENGLISH from Zh. Prik. Mekhan. i. Tekhn. Fiz. (Moscow), no. 6, 1963 p 124–127
(NASA-TT-F-265) CFSTI: HC $1.00/MF $0.50 CSCL 20H

The problem of a gas atom or diatomic molecule striking a solid surface is analyzed and calculated on a computer. A classical mechanical model is used, representing the solid as a straight, effectively infinitely long (10 links), head-on atomic chain. The binding of the chain atoms is assumed to be either elastic coupling or a Lennard–Jones potential. The conditions for stopping, capture, and back-scattering of the incident particle are ascertained. The case when the outermost (surface) atom of the chain is an adsorbed dissimilar atom is analyzed. The results are compared with earlier data, revealing significant discrepancies. Author

N65-34563# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
THERMAL AND CHEMICAL ASPECTS OF THE THERMONUCLEAR BLANKET PROBLEM
William G. Homeyer 29 Jun. 1965 120 p refs
(Contract DA-36-039-AMC-03200(E); Grant NSF GK-57)
(TR-435; AD-619669)

A theoretical study has been made of the blanket that must surround a thermonuclear plasma to provide energy conversion and removal, neutron and gamma-ray shielding, and regeneration of the tritium burned in the D-T reaction. Power distributions and heat transfer have been calculated and materials problems analyzed for blanket assemblies that are capable of tritium regeneration. The blanket arrangement chosen as a model consisted of a molybdenum vacuum wall in the form of a long cylindrical shell, cooled by fused Li_2BeF_4 and surrounded by an annulus, 55 cm thick, consisting of fused Li_2BeF_4 and graphite to channel the flow of coolant. Author

N65-34589* Stanford Univ., Calif. Stanford Electronics Labs.
RADIATION EFFECTS IN OPTICAL MATERIALS
W. E. Spicer *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 123–129 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Mechanisms involved in radiation damage to optical materials and the practical consequences of such damage are considered. A distinction is made between direct electronic displacement damage, direct atomic displacement damage, and indirect atomic displacement damage. Various types of damage are illustrated, and examination is made of threshold damage, spatial distribution of damage, and the importance of perfection and past history of a given material. Simple homogeneous materials, such as quartz, CdS, and alkali halides, are considered; and pigmented thermal control surfaces are discussed as examples of complex, inhomogeneous optical materials which are of importance in space. M.W.R.

N65-34595* Oak Ridge National Lab., Tenn.
PARTICLES EMITTED IN THE FORWARD DIRECTION FROM HIGH-ENERGY NUCLEON–NUCLEUS KNOCK-ON REACTIONS
H. W. Bertini *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 157–160 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

Calculations are given based on the assumption that high energy (~100 MeV) nucleon–nucleus reactions occur via a series of individual particle–particle reactions within the nucleus, where the differential cross sections used in determining the scattering angles in the particle–particle reactions are the free-particle differential scattering cross sections. The shapes of the curves for the n–p and p–p free-particle differential cross sections are plotted versus the laboratory scattering for 40 and 160 MeV neutron–proton and proton–proton reactions, with the data derived from the center of mass cross sections. Plots of these distributions indicate that the distributions decrease for small forward angles as the angle approaches zero. The decrease was attributed to the effect of the exclusion principle on the collisions which occur inside the nucleus. An assumption is also considered that attempts to approximate the exclusion principle in the intranuclear cascade calculation; a schematic energy diagram of a single proton–neutron reaction occurring inside the nucleus is included. M.G.J.

N65-34599* Bendix Corp., Detroit, Mich.
COSMIC-RAY SHOWER PRODUCTION IN MANNED SPACE VEHICLES—COPPER
K. A. More and O. L. Tiffany *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 183–188 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

In previous work we calculated the generation of cosmic ray showers in an aluminum-walled spacecraft by a three-dimensional Monte Carlo technique using intranuclear cascade data. This work has been extended to the case of a spacecraft composed of copper in order to determine the effect of Z on shielding. As before, data on neutron and pion production are of particular interest, since only a model including shower production can give an estimate of these products. The proton results are compared with the simpler calculations using ionization only or ionization and exponential absorption. Author

N65-34604* United Nuclear Corp., White Plains, N. Y.
SYNTHESIS OF SPHERICAL MINIMUM-WEIGHT PROTON SHIELDS
J. Celnik, A. D. Krumbein, and F. R. Nakache *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 225–228 ref (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(Contract NAS8-5277)

A systematic method, developed for minimizing spherical shield weights for protection against proton radiation, is described. Protection is also afforded against secondary neutron production, subject to various specified dose constraints. Variational methods were applied to a radiation model yielding the choice of optimum shielding materials and their mixtures, together with a prescription for their disposition in a multilayer spherical shield. Two cases are discussed: one in which the man occupies only a small fraction of the inner void volume, and the other in which the phantom completely fills the void. Figures depict secondary neutron production in several materials as a function of equivalent aluminum thickness for two solar flare spectra, and for the Van Allen belt spectrum. Six materials were considered: Al, C, Cu, W, CH_2, and C_7H_8O. Results indicate that only polyethylene may be at the outside of the shield, as it is the only material adjacent to vacuum; tungsten can only be adjacent to a pure region of copper, or to a mixed region of tungsten and copper; and three-material mixtures can consist only of combinations of CH_2, C, Al, and/or Cu. M.G.J.

N65-34612* Oak Ridge National Lab., Tenn.
DIFFERENTIAL CROSS SECTIONS BY FLIGHT-TIME SPECTROSCOPY FOR PROTON PRODUCTION IN REACTIONS OF 160-MeV PROTONS IN NUCLEI
R. W. Pelle, T. A. Love, N. W. Hill, and R. T. Santoro *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 331–335 refs (See N65-34575 22-29) GPO: $3.25 CFSTI: MF $2.50
(NASA Order R-104)

Flight time spectroscopy measurements of secondary proton spectra were made using a 160 MeV proton beam from a synchrocyclotron. The reported data consist of raw flight time spectrum from secondary protons observed at 30° using a cobalt target, cross section for the scattering of protons at 60° from water, cross sections for the production of secondary protons at 30° in various targets, cross sections for the production in cobalt of secondary protons at various angles, and laboratory system angle differential cross sections for the production of secondary protons of energy greater than 20 MeV. J.M.D.

N65-34613* Oak Ridge National Lab., Tenn.
COMPARISON OF MEASURED NEUTRON AND PROTON SPECTRA WITH CALCULATED SPECTRA IN THE ENERGY REGION BETWEEN 50 AND 160 MeV
W. A. Gibson, W. R. Burrus, W. E. Kinney, J. W. Wachter, and C. F. Johnson (General Dynamics/Fort Worth) *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 337–339 refs Prepared in cooperation with Gen. Dyn./Ft. Worth (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

The energy spectra of secondary protons and neutrons emerging from targets bombarded by a collimated beam of 160-MeV protons were obtained with a proton recoil spectrometer covering the energy range between 50 and 160 MeV. Secondary proton cross sections are given at 60° for 160-MeV protons incident on a 0.549-g/cm^2 thick aluminum target and secondary neutron cross sections at 45° are given for 160-MeV protons incident on a 3.224-g/cm^2 thick cobalt target. Also, secondary neutron yields from a 26.89-g/cm^2 thick aluminum target at 10° and 45° to the incident 160-MeV proton beam and secondary neutron yield from a 44.33-g/cm^2 thick bismuth target at 10° and 45° to the incident 160-MeV proton beam are given. The incident beam was completely stopped in the target in both cases. The theoretical and experimental cross sections, in general, agree favorably. In most cases the differential cross sections at 45° and 60° integrated with respect to energy from 50 to 160 MeV agree within experimental error. For the transport code calculations, predicted yields were too large. E.E.B.

N65-34614* Oak Ridge National Lab., Tenn.
SPECTRA OF GAMMA RAYS PRODUCED BY INTERACTION OF ≈-MeV PROTONS WITH Be, C, O, Al, Co., AND Bi
W. Zobel, F. C. Maienschein, and R. J. Scroggs *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 341–349 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-104)

For the measurements described a three crystal pair spectrometer was used above 2.0 MeV and an anticoincidence spectrometer was used below 2.5 MeV. The gamma-ray spectrometer requirements were considered to include ascertainable absolute efficiency, high neutron rejection, and an adequate response function. A time-of-flight requirement was also established in order to discriminate against neutron-induced effects. Results are summarized for different targets. These data include the measured energy of the photon, the cross section for its production, corresponding data from the Oxford group where such data have been reported, and possible transitions giving rise to the gamma rays observed. In some entries two values are given for the same transition. These represent measurements made with the spectrometer both in the total absorption mode and in the pair mode. Since there is essentially no line structure noticeable in the data from a Bi target, no cross sections were determined for this case. E.E.B.

N65-34615* Lockheed-Georgia Co., Marietta.
CALCULATION OF PROTON-INDUCED GAMMA-RAY SPECTRUM AND COMPARISON WITH EXPERIMENT
C. W. Hill and K. M. Simpson, Jr. *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 351–355 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

The results of a new attempt to predict secondary gamma rays arising from energetic proton reactions with nuclei are presented and the predictions are compared with reported data for protons of 150 MeV energy. Theoretical gamma ray spectra were calculated for bombarding energies of 25, 50, 100, 150, and 200 MeV. For aluminum targets, the spectrum is constant from 50 MeV to 200 MeV. The total gamma energy per inelastic collision varies by only 4% over this range of bombarding energies. At 25 MeV the spectrum is softer and the gamma energy yield increases 25%. The estimate of gamma ray secondaries shows that this component is relatively small even for fairly thick aluminum shields. However, the uncertainties in the calculation could lower the estimate by a factor of two or raise the estimate by a factor of four. The resolution of the gamma ray problem awaits accelerator experiments below 30 MeV and solar flare flux measurements below 15 MeV. E.E.B.

N65-34616* New York Univ., N. Y.
SOME EXPERIMENTAL DATA ON THE NUCLEAR CASCADE IN THICK ABSORBERS
B. S. P. Shen *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 357–362 refs Supported in part by AEC (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

A series of survey experiments on the passage of high energy protons in solid absorbers have been conducted at the Brookhaven cosmotron. Some raw data suitable for comparison with nuclear cascade calculations are given. Author

N65-34623* National Bureau of Standards, Washington, D. C.
RESULTS OF SOME RECENT TRANSPORT CALCULATIONS FOR ELECTRONS AND BREMSSTRAHLUNG
M. J. Berger and S. M. Seltzer *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 437–448 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(NASA Order R-80)

Illustrative results are given for three types of problems: (1) the transmission of electons through thin and thick foils, with emphasis on the effect of energy loss straggling; (2) the energy dissipation by electrons in a semi infinite water phantom, for an incident broad beam (depth dose distribution), and for an incident pencil beam (distribution as function of two spatial variables); and (3) the production of bremsstrahlung in thick targets. The data presented for the first two problems are entirely theoretical and result from a Monte Carlo calculation. Similar calculations for the third problem are comapred with recent experiments. Author

N65-34624* Ling-Temco-Vought, Inc., Dallas, Tex. Research Center
BREMSSTRAHLUNG PRODUCTION OF THICK ALUMINUM AND IRON TARGETS BY 0.5-TO-3.0-MeV ELECTRONS

L. L. Baggerly, W. E. Dance, B. J. Farmer, and J. H. Johnson *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 449–453 refs (See N65-34575 22-29) GPO: $3.25 CFSTI: MF $2.50
(Contracts NASw-647; NASw-948)

The intensity of bremsstrahlung produced by bombarding thick targets of the important structural materials, aluminum and iron, has been measured as a function of incident electron energy, photon energy, and angle of photon emission. The energy of the incident electrons ranged from 0.5 to 3.0 MeV. The electron beam from a 3 MeV Van de Graaff accelerator was incident normally on targets of sufficient thickness to stop the electrons. The total integrated intensities have been computed from these measurements. Author

N65-34625* General Dynamics/Astronautics, San Diego, Calif.
SPACE ELECTRON RADIATION SHIELDING—BREMSSTRAHLUNG AND ELECTRON TRANSMISSION
G. D. Magnuson and A. W. Mc Reynolds *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 455-463 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

An extensive program of experimental measurements was made using beams of monoenergetic electrons to bombard light metals, plastics, and other potential shielding materials. The angular distribution, intensity, and energy distribution of both transmitted electrons and bremsstrahlung X-rays were measured as a function of incident angle and energy. Transmission curves were determined as a function of electron energy from 0.2 to 2.5 MeV for a number of thicknesses of aluminum and polyethylene from about 0.07 to 1.3 g/cm^2. Transmission coefficient versus angle of incidence curves for aluminum were in good agreement with the Monte Carlo calculations for material thicknesses of about 0.3 but diverge substantially from the calculations at greater thicknesses. Bremsstrahlung intensities were also measured behind laminar aluminum polyethylene structures and showed a broad angular distribution at 0.5 MeV incident energy, increasingly forward peaked at 1.0 and 2.0 MeV in accordance with theory. E.E.B.

N65-34626* Boeing Co., Seattle, Wash.
ERRORS FROM GEOMETRIC APPROXIMATIONS INTRODUCED IN THREE COMPUTATIONAL MODELS FOR SPACE VEHICLE ELECTRON DOSE PREDICTION
R. P. Moshofsky *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 465–471 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Evaluation of shield designs for space vehicles is a complex problem involving the coupling of radiation transport to difficult geometries. Various approximations are made regarding both geometry and physical interactions in order to shorten computation time. It is desirable to know the significance of error introduced by geometric approximations. Using the idea that simplified models should be most nearly valid for simple geometries, three models for electron dose calculation are compared in cases involving spherical shell shields. The explicit differences in these models relate mainly to the treatment of the radiation angular distributions and the shield geometry. Relatively accurate calculations are possible for spherical shell cases so that error estimates are made for the various computational procedures. Author

N65-34627* Boeing Co., Seattle, Wash.
AN EVALUATION OF RADIATION SHIELDING BY VEHICLE ORIENTATION
B. W. Mar *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 473–476 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MC $2.50

An elementary analysis was performed to determine the decrease in shield weight obtained by selective orientation of a vehicle in an anisotropic flux of geomagnetically trapped charged particles. Study results indicate a minor decrease in proton shield weight and electron shield weight. The study was limited to cylindrical and conical geometries; the energy spectra were assumed to be independent of pitch angle, whereas angular distribution was a function of pitch angle (maximum cutoff angle of 60 degrees). Author

N65-34628* Northrop Space Labs., Hawthorne, Calif.
THE IMPORTANCE OF RADIATION ANISOTROPY IN DOSE CALCULATIONS
R. E. Fortney and G. D. Duckworth *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 477-481 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

In order to assess the importance of radiation anisotropy, computer programs were used to calculate the normalized isotropic dose rate for each solid angle and weight this value with the fraction of the omnidirectional flux incident with the respective pitch angle. This fraction or weighting factor was obtained using a normalized polynomial expression representing the pitch angle distribution. Anisotropic and isotropic dose calculations were made for seven different vehicle orientations and the results are presented. For each orientation, the ratio of anisotropic dose rate to the isotropic dose rate is given to indicate the relative importance of radiation anisotropy in dose calculations. It is shown that anisotropy of space radiation must be considered for certain orientations. The dose at specific points in an astronaut, such as eyes and localized critical organs, should be investigated considering the anisotropy of the trapped radiation. E.E.B.

N65-34693# Stanford Univ., Calif. High Energy Physics Lab.
ETA PHOTOPRODUCTION IN THE REGION FROM THRESHOLD TO 900 MeV
R. Prepost, D. Lindquist, and D. Quinn May 1965 19 p refs Presented at the Intern. Symp. on Electron and Photon Interactions at High Energies
(Contract Nonr-225(67))
(HEPL-384; AD-618660)

Measurements of the differential cross section of the process $\gamma + p \rightarrow \eta^0 + p$ have been made in approximately 50 MeV intervals from threshold to 900 MeV. The yield of recoil protons is measured at a fixed momentum and angle as a function of the bremsstrahlung end point energy, and eta production is seen as a step in the proton yield at the appropriate threshold energy. The differential cross section at 90° is characterized by a sharp rise near threshold reaching a maximum value of 1 μb/sr at 760 MeV, and then falling off to a value of 0.3 μb/sr at 900 MeV. A measurement of the differential cross section for 3 different angles at 790 MeV indicates that the cross section is isotropic in the center of mass at this energy. The interpretation of these results in terms of possible contributing partial waves will be discussed. Author

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N65-33712*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DIPOLE RESONANCES IN A HOMOGENEOUS PLASMA IN A MAGNETIC FIELD
Peter A. Sturrock [1964] 24 p refs Submitted for Publication
Prepared jointly with Stanford Univ.
(NASA-TM-X-51880) CFSTI: HC $1.00/MF $0.50 CSCL 20I

Radar observations recently made from a satellite orbiting above the ionosphere provide evidence for resonances of a plasma in a magnetic field which may be excited and detected by a dipole. The plasma may be said to be resonant, for a particular mode and frequency, if the group velocity is zero. These resonances are studied theoretically on the assumption that the dipole is of infinitesimal extent and that the plasma is excited by a charge or current impulse. The former assumption restricts the validity of the results to the asymptotic response of the plasma. The latter assumption is not a restriction. There are two electromagnetic resonances at the positive-frequency roots of $\omega^2 \pm \Omega\omega - \Pi^2 = 0$, where Ω is the electron gyro frequency and Π the electron plasma frequency, which occur at $k = 0$. There is also a resonance at $\omega = \Omega$, $k = \infty$, but this cannot be treated by the infinitesimal-dipole approximation and is deferred for separate study. Author

N65-33713*# AVCO-Everett Research Lab., Everett, Mass.
EXPERIMENTS WITH MAGNETOHYDRODYNAMICALLY SUPPORTED SHOCK LAYERS
E. Locke, H. E. Petschek, and P. H. Rose Jul. 1964 36 p refs Submitted for Publication
(Contract NASw-748)
(NASA-CR-58153) CFSTI: HC $2.00/MF $0.50 CSCL 20I

Shock tube experiments have been performed to quantitatively determine the interaction of a hypersonic flow with the magnetic field of a straight current-carrying wire oriented perpendicular to the flow direction. The interaction which takes place in a thin layer behind a detached shock wave is subject to the following restrictions: (1) Negligible conductivity upstream of the shock; (2) Low magnetic Reynolds number and scalar conductivity in the shock layer. The straight wire geometry under these restrictions has been analyzed theoretically by Levy and Petschek. The analysis, which is briefly reviewed, predicts the location of a thin shock layer which is concentric with the wire. Most of the experimental work was performed in a 50–50 mixture of argon and oxygen, at an initial pressure of 1 mm Hg, and in a range of shock velocities between 4.3 and 6 mm/μsec. Data were obtained by observing the flow luminosity, using an image converter and mirror camera looking both perpendicular to and along the wire. A circular shock front was observed to stand up to 5-1/2 cm in front of a 1 cm radius cylinder producing the magnetic field. Author

N65-33722*# Southwest Center for Advanced Studies, Dallas, Tex.
RADIATION FROM ELECTRONS IN A MAGNETOPLASMA
Harold B. Liemohn [1964] 71 p refs Submitted for Publication
(Grant NsG-269-62)
(NASA-CR-58142) CFSTI: HC $3.00/MF $0.75 CSCL 20I

The properties of radiation from an electron in a homogeneous magnetoplasma as a consequence of the dispersive anistropic nature of the medium are investigated. The frequency spectra and angular patterns of the average radiated power are calculated by the Hamiltonian method. The theory of emission in dispersive anistropic media with a hermitian dielectric tensor is reviewed and extended to relativistic energies. The analytic formulas for the power are evaluated for several special cases, and the results are applied to recent interpretations of very low frequency (vlf) and low frequency (lf) emissions from electrons in the magnetosphere. Results show that in the ordinary whistler mode most of the energy is radiated along wave normals at large angles to the magnetic field at frequencies other than the rectilinearly Doppler-shifted fundamental cyclotron harmonic frequency. The total power in the ordinary mode is a slowly varying function of frequency and electron energy with an average level of 10^{-30} watts/(c/s) per electron. This level indicates that the dispersion patterns of vlf emissions cannot be explained on the basis of incoherent emission, but must be interpreted by means of the coherence mechanism. G.A.L.

N65-33894# Lincoln Lab., Mass. Inst. of Tech., Lexington.
AC BREAKDOWN IN GASES
Charles E. Muehe 26 Feb. 1965 31 p refs *Its* Tech. Rept.-380
(Contract AF 19(628)-500)
(ESD-TDR-65-53; AD-618503)

The breakdown potential of helium, neon, argon and xenon was measured over the frequency range from DC to 1000 Mcps, and the pressure range from 10^{-3} to 600 mmHg employing a glass breakdown cell with 1-cm spacing. Graphs showing contours of constant breakdown potential as a function of pd and d/λ are presented. These graphs show three distinct breakdown regions: (1) the diffusion-controlled region, (2) the secondary-electron-emission (multipactor) region, and (3) the low-frequency region. The breakdown mechanism in each of these regions is explained. An extensive bibliography on AC breakdown in gases is included. Author

N65-33905# RAND Corp., Santa Monica, Calif.
WAVE PROPAGATION IN INHOMOGENEOUS ISOTROPIC HOT PLASMAS
H. Unz (Kansas Univ., Lawrence) Jul. 1965 25 p refs
(P-3178; AD-618560)

The three dimensional coupled wave equations for the electromagnetic and the acoustic waves propagating in inhomogeneous, isotropic, hot plasma are derived from the linearized electro-magneto-plasma-gas-dynamics equations. The wave equations become uncoupled for propagation in the direction of the inhomogeneity. An asymptotic solution for this case is given. Author

N65-33908# Midwest Research Inst., Kansas City, Mo.
HIGH-PRESSURE SAMPLING CONFERENCE REPORT
Thomas A. Milne 23 Jul. 1965 36 p refs Conf. held at Midwest Res. Inst., 6–7 May 1965
(Contract Nonr-3599(00); ARPA Order 23-63)
(AD-618566)

Various problems encountered in the direct sampling of systems at high pressures were discussed. Abstracts, which indicate the range of topics covered, include *Continuum Flow Problems in Direct Sampling; Nonequilibrium Effects in Freely Expanding Jets; Mass Bias in Vacuum Sampling from High Pressure; Influence of Self Collisions in Supersonic Molecular Beams; Collisions in Molecular Beam Collimating Chambers; Disturbances by Sonic Sampling Probes in Flames and Other Systems; Free Radical Sampling from Nonequilibrium Systems; Some Problems of Mass Spectrometric Direct Sampling; Direct Sampling from a Shock Tube; Beam Formation and Sampling of Neutrals from One Atmosphere Flames; A Sampling System for Neutral Particles; Ion Sampling from Gaseous Plasmas; Ion Sampling from a Flowing Gas Stream; and Ion Sampling from Hydrocarbon Combustion Plasmas.* M.G.J.

N65-34014# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

MAGNETOHYDRODYNAMIC EFFECTS ON SUPER-ORBITAL RE-ENTRY VEHICLES

Roger Clay Lewis (M.S. Thesis) Jun. 1965 90 p refs (GSP-65B/ME/65-1; AD-618028)

The application of a magnetic field to a lifting reentry vehicle will change the stagnation point heat flux and increase the drag over the nose. Also, a vehicle weight increase is usually associated with the addition of the field generating equipment. A computer program was written to analyze these effects. At each point in the reentry trajectory, the program calculates the optimum magnetic field which will minimize the heat flux. The heat flux to the stagnation point is computed using either the optimum magnetic field or a field of one Weber/m^2, whichever is smaller. A study was performed on the Sortie vehicle assuming a reentry velocity of 35 000 ft/sec. The optimum field was always greater than one Weber/m^2. The influence of MHD on the maximum wall temperature was greatest at the minimum reentry angle. The weight of the field generating equipment will adversely affect the maximum wall temperature. For given conditions there is a critical weight increase at which the maximum wall temperature with MHD and the additional weight is equal to the maximum wall temperature without MHD and at the original weight. Results indicate that MHD effects are in general small, and are significant only on vehicles with $W/C_LA < 100 lb/ft^2$. Author

N65-34017# Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.

COMPOSITION OF NOBLE GAS ION BEAMS PRODUCED WITH A DUOPLASMATRON

C. M. Braams, P. Zieske, and M. J. Kofoid Jun. 1965 23 p refs (DI-82-0437; AD-618383)

Beams of noble gas ions produced with a duoplasmatron ion source were magnetically analyzed while the gas pressure in the source was varied. At high pressure the beam consisted primarily of singly-charged ions. With decreasing pressure the yield of multiply-ionized ions increased and was finally limited by the rising arc voltage which caused overheating of the anode. No measurable amount of He^{2+} or Ne^{2+} was detected. In the other gases the following maximum yields were measured for the more highly ionized species: 63% A^{2+}, 54% Kr^{2+}, 16% Kr^{3+}, 24% Xe^{2+}, and 1.2% Xe^{3+}. Traces of molecular ions were detected in all the noble gases studied. Author

N65-34077 Library of Congress, Washington, D. C. Aerospace Technology Div.

SOVIET RESEARCH ON BALL LIGHTNING

Arsen Iwanovsky *In its* Foreign Sci. Bull., V. 1, No. 9 Sep. 1965 p 30–41 refs (See N65-34075 22-34)

Soviet studies on problems related to ball lightning and associated experiments are reviewed, and several of the theories advanced to explain the phenomena are discussed. It is pointed out that since 1960 an extensive Soviet theoretical study has been conducted in areas that might be applicable to this entire complex of problems, although articles on ball lightning per se were extremely scarce during this period. The potential capabilities of controlled ball lightning as a military weapon are also mentioned in the literature. Listed as significant indicators of Soviet interest in this area are: (1) the advanced state of high voltage and artificial lightning research; (2) the fact that scientists are studying the problem; (3) interest in high power microwave engineering and its relationship to the problem of artificial ball lightning; and (4) extensive research on plasmoids in relation to the problem of controlled thermonuclear reactions. M.G.J.

N65-34087# Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.

A REVIEW OF MICRO-WAVE TECHNIQUES IN PLASMA STUDIES [SURVOL DES TECHNIQUES MICRO-ONDES POUR L'ETUDE DES PLASMAS]

Terenzio Consoli Oct. 1964 81 p refs In FRENCH and ENGLISH Presented at the 7th Comm. of the Gen. Assembly of the U.R.S.I., Tokyo, Sep. 1963 (CEA-R-2427) CFSTI: HC $3.00/MF $0.75

CONTENTS:

1. A REVIEW OF MICRO-WAVE TECHNIQUES IN PLASMA STUDIES T. Consoli p 1–66 refs

2. PRELIMINARY MEASUREMENTS OF WHISTLER-MODE PROPAGATION IN A θ-PINCH DISCHARGE U. Hope and M. Tutter (Max-Planck-Inst. für Phys. und Astrophys.) p 67–69 ref (See N65-34088 22-25)

3. A MICROWAVE-DUAL-INTERFEROMETER FOR PLASMA DIAGNOSTIC G. Lisitano (Inst. für Plasmaphys.) p 70–75 refs (See N65-34089 22-25)

4. PRELIMINARY RESULTS OF MICROWAVE DIAGNOSTICS H. Beerwald and E. Geibler p 76–78 (See N65-34090 22-25)

N65-34088 Max-Planck-Institut für Physik und Astrophysik, Munich (West Germany).

PRELIMINARY MEASUREMENTS OF WHISTLER-MODE PROPAGATION IN A θ-PINCH DISCHARGE

U. Hopf and M. Tutter *In* Comm. a l'Energie Atomique A Rev. of Micro-Wave Tech. in Plasma Studies Oct. 1964 p 67–69 (See N65-34087 22-25) CFSTI: HC $3.00/MF $0.75

An oscillogram of an interference signal, made up by the superposition of a 4 mm wave transmitted across the middle axis of the discharge tube with its reference signal, was shown. The interference signal of the reflected wave with the same reference was also shown. During the interesting part of the discharge time no measurable signal propagates through the plasma. The strength of the magnetic field due to the external circuit was about 10^4 Gauss during the exciting current maxima. It seemed reasonable to attempt to propagate 3 cm waves in the whisler mode parallel to the magnetic field lines. A photograph of the double probe used was shown. It consists of two small stub-antennas which are the ends of the inner conductors of two thin coaxial lines transmitted from one antenna to the other. The line between the Whistler signals gave the zero amplitude. R.W.H.

N65-34089 Institut für Plasmaphysik G.m.b.H., Garching (West Germany).

A MICROWAVE-DUAL-INTERFEROMETER FOR PLASMA DIAGNOSTIC

G. Lisitano *In* Comm. a l'Energie Atomique A Rev. of Micro-Wave Tech. in Plasma Studies Oct. 1964 p 70–75 refs (See N65-34087 22-25) CFSTI: HC $3.00/MF $0.75

This paper describes an interferometer which radiates two microwave frequencies through a plasma, in order to obtain a better approximation of the plasma density. By comparing the phase shift of the two waves it is also possible to determine the equivalent diameter of a plasma column of uniform density. The two waves used are an 8 mm fundamental wave and its first harmonic. Author

N65-34090 Comissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.

PRELIMINARY RESULTS OF MICROWAVE DIAGNOSTICS

H. Beerwald and E. Geibler *In its* Rev. of Micro-Wave Tech. in Plasma Studies Oct. 1964 p 76–78 (See N65-35087 22-25) CFSTI: HC $3.00/MF $0.75

An experimental arrangement was shown which indicated that when the amplitude of the field was increased linearly, a breakdown of the ring discharge was observed as a strong rise of the electron density. Breakdown voltage was measured as a function of pressure, initial electron density, magnetic bias field, and diameter of the discharge tube. Inteferometric measurements were done with 8 mm wavelength and sometimes with 4 mm. Plasma velocity in an axial direction due to the end losses in θ-pinch discharge could be measured by means of the Doppler-effect, if there was no preheating. R.W.H.

N65-34105# Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.
THE EXCITATION OF HIGHER MODES BY THE HELICAL INSTABILITY
Roy R. Johnson Apr. 1965 48 p refs
(DI-82-0439; AD-618380)

The conditions whereby the helical instability can excite higher modes in the plasma column are investigated. As the amplitude of the helical instability increases it changes the radical distribution of the averaged charge density. The finite amplitude theory of the helical or m = 1 instability is employed to determine the averaged charged density which is then used to determine the conditions for the onset of the m = 2 instability. These results are then combined with the energy balance relationship of the positive column. The wavelengths and frequencies of the helical and m = 2 modes are determined for the conditions at the onset of the m = 2 mode. The wavelength of the m = 2 mode is found to be shorter than for the helical mode whereas the frequency is found to be greater. Author

N65-34124# Innsbruck Univ. (Australia). Inst. for Theoretical Physics.
THE JUELICH PLASMA SYMPOSIUM Scientific Report
Ferdinand Cap and Karl Lackner 14 Jul. 1964 24 p
(Contract AF 61(052)-675)
(SR-15; AD-613622) CFSTI: HC $1.00/MF $0.50

Summaries of papers presented at the European Study Group on Fusion are presented under the headings of pinch discharges and related investigations, plasma acceleration, plasma confinement, and plasma diagnostics. Theoretical aspects of the conference are emphasized in the first section of the report which reviews investigations dealing with subjects such as plasma drift in the thetatron, θ-pinch rotation and stability, rotating plasma and plasma beam interaction, magnetohydrodynamic shock profile, combination of z-pinch with θ-pinch, and a highly reproducible screw pinch. Acceleration studies are concerned with a ring model, thetatron guns, two-stage electrodeless plasma gun, and high frequency accelerators. The boundary layer between a relativistic zero temperature plasma and a magnetic field, runaway electrons in an rf mirror field, ion injection into a magnetic cusp field, and stability of plasma trapped in a magnetic mirror are also discussed. M.W.R.

N65-34193# Strathclyde Univ., Glasgow (Scotland). Dept. of Mathematics.
RESEARCH ON MAGNETO-GASDYNAMICS Final Scientific Report
D. C. Pack 15 Feb. 1965 7 p refs
(Grant AF-EOAR-6-64)
(AFOSR-65-1069; AD-618296)

An analysis has been made of the rectilinear, adiabatic but non-isentropic, unsteady flow of a perfectly conducting ideal gas moving in the presence of a transverse magnetic field. Detailed properties of certain generalized simple waves have been obtained. The upstream influence effects in the flow of a perfectly conducting fluid over an insulating wall have been found on the basis of linearized theory. The question of the physical realization of the solutions found by Cabannes for flow of perfectly conducting gas past a wedge in a magnetic field aligned with the stream has been examined by a combination of analytical and heuristic arguments. Magneto-gasdynamic deflagrations under the Chapman-Jouget condition have been studied and work has been initiated on similarity solutions for cylindrical magneto-gasdynamic detonations and flames. Author

N65-34278# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
A KINETIC THEORETICAL INVESTIGATION OF A FULLY IONIZED GAS. PART III: A THEORY OF ELECTRON GAS
Toyoki Koga May 1965 29 p
(Contract Nonr-839(38); ARPA Order 529; Proj. Defender)
(PIBAL-863; AD-468181)

A kinetic theory of electron gas is developed. At the first step of approximation, one field electron interacts with the test electron in the sense of Boltzmann's binary collision when those two particles are their mutual nearest neighbors; otherwise the field electron, with the others, exerts a force of the Vlasov type on the test electron. At this stage of approximation, one field electron represents all the field electrons: there is no mutual correlation among the field electrons. In the second approximation, where two electrons represent the field electrons, the pair of field electrons, when they are mutual nearest neighbors, become a source of fluctuating force-field due to their mutual interaction. In the third approximation, three electrons represent the field electrons. As the step of approximation proceeds, the pairs of electrons produce more complex force-fields by their mutual interactions. The kinetic equation of the single-particle distribution function contains interaction terms of the Vlasov type, of the Boltzmann type, and of the Fokker-Planck type. There is no difficulty of divergence in the effect. Author

N65-34285# Arkansas Univ., Fayetteville. Plasma Lab.
[RESEARCH ON THE INTERACTIONS OF PLASMA FLOW AND MAGNETIC FIELDS] Quarterly Progress Report, 15 Nov. 1964–15 Jan. 1965
[1965] 6 p
(Contract DA-23-072-AMC-168(Z))
(UAPL-23; AD-463780)

Continued research conducted under a program designed to study interactions of plasma flows and magnetic fields is reported. Presented are results of theoretical and experimental studies in magnetohydrodynamics and superconductivity. Experiments were performed to establish the optimum conditions for signal detection, and inherent problems associated with using simple arc discharges were investigated theoretically. Numerical evaluations were initiated to investigate the voltage induced between the interaction of a conducive ring and solenoidal magnetic field. In view of the need for large amounts of electrical power for communication through the plasma sheath which is formed around a space vehicle reentering the earth's atmosphere, a theoretical investigation on the MHD electrodeless generator was initiated to explore the possibility of using a one-sided electrodeless generator. Equipment and apparatus required to conduct the second phase studies in superconductivity were selected, specified, and ordered. A coil with a design storage of 10-Joules was designed and construction begun. Studies are continuing on the problem of switching with additional measurements being made on the transients involved if the currents are not switched simultaneously. The design of a superconducting switch was also begun. S.C.W.

N65-34330*# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
NOTES ON MAGNETOHYDRODYNAMICS, PART II
R. P. Kanwal and John S. Nisbet 30 Sep. 1965 52 p refs *Its* Sci. Rept.-251
(Grants NsG-134-61; NSF GP-4026)
(NASA-CR-67084) CFSTI: HC $3.00/MF $0.50 CSCL 20I

Simple waves and covariant formulation are considered in relation to magnetohydrodynamics. Equations are developed for one-dimensional wave propagation in classic gas dynamics, and Riemann invariants are derived for fast and slow waves. These invariants are obtained directly from the integral of an equation whose integral curves are plotted graphically. Since the velocity vector does not enter the equations, the Reimann invariants are called magnetic; their values are determined by those in a constant state. The analysis made for fast and slow simple waves is extended to compression and rarefaction propagation; and intermediate simple waves and material layers are also considered. A perfect and infinitely conducting fluid in the covariant formulation and a definitive system of equations permits the subsequent analysis. Sonic disturbances, Alfvén waves, fast and slow waves, space-time representation, bicharacteristics, and geometry of the wave fronts are considered in relation to covariant formulation. M.W.R.

N65-34337# AVCO-Everett Research Lab., Everett, Mass.
THOMSON SCATTERING MEASUREMENTS OF MAST PLASMAS
R. M. Patrick Aug. 1965 28 p refs Submitted for Publication
(Contract AF 49(638)-1483)
(AVCO-Everett-Res. Rept.-218; AD-470072)

Measurements of Thomson scattering from the plasma electrons created by high speed shock waves in a magnetic annular shock tube have been used to determine the electron density behind the shock waves and some preliminary measurements of the electron velocity distribution. A Q-switched ruby laser furnished the light beam which was scattered by the plasma electrons. A rotating quartz prism furnished the Q-switching of the optical cavity for the ruby laser, and rather long Q-switched pulses were obtained (between 10^{-7} and 10^{-6} sec duration). The power level during the Q-switched pulse was between 30 and 100 megawatts. Rayleigh scattering from an air sample at various pressures was used to calibrate the power output of the laser and gave a simultaneous measure of the laser output power for all of the tests, while the Thomson scattering was being measured. The measurements of the electron density using the Thomson scattering and the plasma continuum intensities agreed within the scatter of the data. The electron temperature measurements obtained with the Thomson scattering showed that the electron temperature increased with increasing shock speed for a given initial condition. Author

N65-34386# Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.
STABILITY DIAGRAMS FOR MAGNETOGASDYNAMIC CHANNEL FLOW
F. D. Hains May 1965 29 p refs Presented at the Fluid Dyn. Div. Meeting of the Am. Phys. Soc., Pasadena, Calif., 23–25 Nov. 1964 *Its* Flight Sci. Lab. Rept. No.-97
(DI-82-0438)

A study is made of the influence of a coplanar magnetic field on the stability of a conducting fluid flowing between parallel planes. After derivation of the general stability equations for small magnetic Reynolds number, numerical results are obtained for the case where initial perturbations of the magnetic field vanish. This must occur if the channel walls have zero or infinite conductivity. Four sets of stability diagrams are presented so that each stability curve will represent the effect of a given applied magnetic field as only one of the four quantities in the Reynolds number is changed. The flow is always stable for initial disturbances of the field produced by passage of a pulsating current through walls of finite conductivity. Author

N65-34387# United Kingdom Atomic Energy Authority, Culham (England). Research Group.
STABILITY OF MAGNETIC WELLS FOR A PLASMA AT FINITE PRESSURE
J. Andreoletti Jan. 1965 6 p refs Transl. into ENGLISH from Compt. Rend. Acad. Sci. (Paris), v. 259, Oct. 1964 p 2392–2395
(CLM-TRANS-5) CFSTI: HC $1.00/MF $0.50

The influence of the curvature of the magnetic field lines and consequently of the transverse depth of a magnetic well on stability has been demonstrated in the limit of weak anisotropy. In this paper we demonstrate in a similar form the influence of the curvature and of the anisotropy which are related to the transverse depth of the well and to its longitudinal depth respectively. Author

N65-34392*# General Dynamics Corp., San Diego, Calif. General Atomic Div.
EXPERIMENTAL INVESTIGATION OF THE FUNDAMENTAL MODES OF A COLLISIONLESS PLASMA Annual Summary Report, 10 Mar. 1964–31 Mar. 1965
David L. Book, John H. Malmberg, and Charles B. Wharton 17 May 1965 41 p refs
(Contract NAS7-275)
(NASA-CR-67099; GA-6335) CSCL 20 I

The dispersion relations for the electrostatic waves in collisionless plasma have been measured near the electron cyclotron frequency. Several waves are observed, including the C_{01} backward wave between the cyclotron frequency and the upper hybrid frequency and the plasma perturbed $T_{e\|}$ wave guide mode. The cyclotron waves are heavily damped. The Landau damping of the electrostatic modes of a plasma with finite radial dimensions is investigated theoretically. The growth of these electrostatic modes due to a beam whose energy depends on radius is also calculated. Author

N65-34399*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ELECTRON DENSITY AND TEMPERATURE MEASUREMENTS IN THE EXHAUST OF A MPD SOURCE
A. J. Kelly, N. M. Nerheim, and J. A. Gardner 15 Sep. 1965 13 p refs
(Contract NAS7-100)
(NASA-CR-67060; JPL-TR-32-798) CFSTI: HC $1.00/MF $0.50 CSCL 20I

Electron density and temperature profiles were measured in the exhaust of a Magneto-Plasma-Dynamic (MPD) source operated in a vacuum facility which provides background pressures of from ~ 100 to ~ 1,000 μ. Electron density profile measurements, made at several stations downstream of the source by using a Langmuir probe (flashed prior to each measurement) and a 24-Gc/sec microwave swinging arm probe, show agreement to within a factor of two over their common range of measurement (2×10^{12} cm^{-3} → 7×10^{13} cm^{-3}). Spectroscopic measurements, utilizing relative ion line intensities at the exit plane of the source, yield electron temperatures in the range 16,000 to 20,000° K for argon mass flows of 0.2 to 0.5 g/sec and currents of 750 to 2,000 amp. Electron temperature profiles, measured 56 cm downstream of the source, have maximums of 6,000 to 7,000° K, which are

consistent with collision frequency data obtained with the microwave probe at this station. Author

N65-34445# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AN INVESTIGATION OF WAVES OF IONIZATION IN A PULSED DISCHARGE
Harold E. Johnson (M.S. Thesis) Jun. 1965 67 p refs (GGC/EE/65-7; AD-618683)

This study consists of a series of experiments in plasma physics to glean information about the time history of the initiation of a glow discharge in a low pressure gas. General characteristics of a specific glow lamp containing an admixture of mercury vapor and argon are determined. Subsequent experiments are performed spectrally by use of spectroscope, photomultiplier and image converter methods, to evaluate the conditions of the plasma from initial breakdown through the initiation of the first striations. A novel and generally useful method of time resolved, spectrally resolved, absorption measurement is demonstrated with application to the present investigation. Author

N65-34448# RAND Corp., Santa Monica, Calif.
ON WAVE PROPAGATION IN ISOTROPIC HOT PLASMAS
H. Unz Jul. 1965 25 p refs (P-3176; AD-618559)

The electro-magneto-plasma-gas-dynamics (EMPGD) equations are summarized, based on the single fluid, continuum theory, macroscopic plasma dynamics theory. The derivation of the three dimensional wave equations for linearized, isotropic, compressible, hot plasma is reviewed. In accordance with a well used approach in the theory of elasticity, the wave equations are separated into the acoustic (longitudinal) and the electromagnetic (transverse) waves. Author

N65-34471# Illinois Univ., Urbana. Charged Particle Research Lab.
PARAMETRIC STUDIES OF ELECTROHYDRODYNAMIC SPRAYING
Robert J. Pfeifer 19 Jun. 1965 132 p refs (Contract AF 33(615)-1459; Grant AF-AFOSR-107-64) (CPRL-4-65; AD-466921)

Mathematical models for the following three parameters of electrohydrodynamic spraying from high potential capillaries are presented: (1) The electrical field at the capillary tip; (2) the rate of mass flow through the capillary; and (3) the electrical conductivity of the working fluid. Studies were based on the mechanics of perturbation growth in fluid surfaces, and on the kinetics of conduction in electrolytic solutions. Experimental plots of charge-to-mass ratio as a function of the electric field at the capillary established the conductivity in the low field region (less than 250×10^5 volts/meter) as a function of the square of the electric field in the intermediate field region (between 250×10^5 and 700×10^5 volts/meter) as independent of the field; and in the high field region (above 700×10^5 volts/meter) as exponentially dependent on the electric field. These theoretical explanations agreed with observed experimental results. G.G.

N65-34495# Columbia Univ., New York. Plasma Lab.
NORMAL IONIZING SHOCK WAVES
R. Taussig Jul. 1964 58 p refs (Contract AF 49(638)-1254) (Rept.-12; AD-619206)

Solutions to the steady state jump equations are obtained for a normal ionizing shock wave propagating into a nonconducting, quiescent gas in an electromagnetic field. Comparison of these solutions to pure MHD shocks and ordinary gas shocks indicates that ionizing shocks are hybrids having some properties common to both MHD and gas shocks. In addition, some completely novel effects are produced by the upstream electromagnetic field. A modified Rankine-Hugoniot function is derived and used to select physically reasonable shock solutions. Solutions analogous in some respects to detonation-deflagration waves have been found, and the Chapman–Jouguet condition is applied to them. The complete boundary value problem is solved numerically in the context of an electromagnetic annular shock tube. Solution of the boundary value problem places the analytic results in the framework of experimentally observable phenomena and emphasizes the differences between ionizing shocks and MGH or gas shocks. Author

N65-34505*# Texas Univ., Austin.
CURRENT SHEATH DYNAMICS AND MAGNETOSONIC OSCILLATIONS IN MAGNETOPLASMAS
Otto M. Friedrich, Jr., and Arwin A. Dougal Washington, NASA, Oct. 1965 138 p refs (Grant NsG-353) (NASA-CR-309) CFSTI: HC$4.00/MF $1.00 CSCL 20I

An analytical and experimental investigation of the electrical breakdown, current sheath formation, and acceleration of current sheaths in deuterium, hydrogen, and argon plasmas is presented. A system of partial differential equations is written from Maxwell's electromagnetic field and plasma equations to describe the current density, resistivity, electron temperature, ion temperature, and degree of ionization as functions of position and time. The subsequent motion of dynamic current sheaths in a parallel plate accelerator is calculated, and three experimental geometries are employed to produce and accelerate the dynamic current sheaths. The diagnostic techniques employed include a 3.39 micron coupled infrared maser resonator; double electrode, unbiased, electrostatic probes; high speed Kerr cell photography; piezoelectric pressure sensitive probes; small magnetic probes; and high voltage-current input measurements. C.T.C.

N65-34600* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE APPLICATION OF THE LIOUVILLE THEOREM TO MAGNETIC SHIELDING PROBLEMS
A. D. Prescott, E. W. Urban, and R. D. Shelton *In* NASA, Washington 2d Symp on Protec. against Radiations in Space 1965 p 189–198 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

In this approach to magnetic shielding problems, it was assumed that the distribution of particles and fields is time independent and axially symmetric about a localized current distribution in the neighborhood of the coordinate origin; that the field extends to infinity; that there are no collisions between particles; and that the particle distribution at large distances is spatially uniform. In the space composed of the six coordinates of position and velocity, the particle distribution is described by a density function which, by the Liouville theorem, is constant along a particle trajectory in this space. It was shown that the flux can be calculated in each shielded and partially shielded region defined by a critical point, provided that the critical point can be found. The technique of finding the critical points in infinitesimal multipole fields and in the fields of two finite parallel current loops was demonstrated, and the complex behavior of the saddle points in the double current loop system was shown. Several examples illustrate the problem, and the role of partially shielded regions in the application of magnetic fields to shield space vehicles is emphasized. M.G.J.

N65-34601* AVCO-Everett Research Lab., Everett, Mass.
MAGNETIC RADIATION SHIELDING USING SUPERCONDUCTING COILS
R. E. Bernert and Z. J. J. Stekly *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 199–209 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(Contract NAS8-5278)

The two present choices of shielding against space radiation are passive bulk shields and active magnetic shields. This paper presents an analysis of superconducting magnetic shield systems to determine the total weight of this type of active shield. The major components of the superconducting magnet considered are superconducting wire, support structure, and cryogenic environment. From this analysis, an optimum system mass is determined as a function of shielded volume and shielding level. Of three magnetic field geometries analyzed, the best configuration on the basis of weight was found to be a spherically shaped shield consisting of a set of nested toroidal windings having a confined magnetic field and a field free shielded cavity in the center of the sphere. Because of a difference in the shielding mechanism of magnetic and passive shields, the dose rate behind shields of equal threshold levels differs, in general being lower for the magnetic shields. Accordingly, the shielding values of magnetic and passive shields are compared on a dose rate basis rather than on a threshold energy basis. The general results of this comparison show that as shielded volumes and shielding levels increase, the advantage of using magnetic shields also increases. A preliminary study of mission requirements was also conducted and is summarized by presenting a design of a Mars class solar flare storm cellar. Author

N65-34602* AVCO-Everett Research Lab., Everett, Mass.
PLASMA RADIATION SHIELDING
Richard H. Levy and G. Sargent Janes *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 211–215 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50
(Contract AF 49(638)-659)

Available methods of solving the radiation shielding problem are reviewed, and comparative weights for different shielding systems are shown. A plasma radiation shielding scheme is proposed, based on the fact that under suitable conditions electrons do not flow across magnetic field lines; therefore, in the presence of a magnetic field strong enough to control the electron motions, a space vehicle might be maintained at a very high potential relative to infinity. Two principal physical requirements are considered. The first is a lightweight means of charging the vehicle; the second is an effective mechanism for containing electrons away from the vehicle. This containment mechanism also provides the basis for a simple charging scheme. The proposed shield is basically electrostatic and repels protons as it is positively charged; a diagram illustrates the principle involved. Typical plasma radiation shield quantities independent of the magnitude of the losses are tabulated, and a schematic diagram of a space vehicle using the shield is included. M.G.J.

N65-34686# Case Inst. of Tech., Cleveland, Ohio.
A STUDY OF HYDROMAGNETIC SHOCKS AND ALLIED PROBLEMS Final Report, Apr. 5, 1960–Oct. 31, 1964
O. K. Mawardi 1 Jun. 1965 14 p refs
(Contract AF 19(604)-7287)
(AFCRL-65-426; AD-619999)

This report describes theoretical and experimental investigations on the onset mechanism of an electromagnetically driven shock wave, on the dynamics of current sheets and on the propagation of waves in nonuniform magnetic fields. Brief descriptions of a number of separate investigations undertaken in these areas are presented and in each case reference is made to appropriate publications from which additional detailed information may be had. Author

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N65-33663* Texas A&M Univ., College Station.
MAGNETIC PROPERTIES OF SOLIDS
Charles F. Squire, Tom W. Adair, R. Zamecki, and E. Sharp *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 20 p refs (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

Torque measurements were made, using a very sensitive torsion pendulum system, on single crystals of NaCl, KCl, and LiF to investigate a new magnetic effect reported previously in the literature for LiF single crystals. Torque was measured as a function of field orientation relative to the crystalline axis. Crystalline axes were determined by X-ray diffraction. The results of the measurements are plotted, and the data curves are discussed in terms of a fixed-to-the-lattice residual magnetization. Also shown are data curves which are not symmetric about the zero deflection axis, but are shifted toward left deflection. Other data and curves are also discussed. Generally the data indicate that the new magnetic effect can be attributed to lattice imperfections such as dislocations or certain types of vacancies in high purity, optical quality, single crystals of alkali halides. L.S.

N65-33708*# Rensselaer Polytechnic Inst., Troy, N. Y. Materials Engineering Dept.
DISPERSION STRENGTHENING MODELS
J. S. Hirschhorn and G. S. Ansell [1964] 9 p refs
(Grant NsG-38)
(NASA-CR-56745) CFSTI: HC $1.00/MF $0.50 CSCL 20K

Various theoretical models, proposed to explain the observed strengthening behavior of crystalline solids containing a uniform dispersion of fine particles, are discussed. It is pointed out that although essentially the same dislocation-particle interaction model and similar criteria for yielding are used, results vary due to the treatment of these interactions in relation to particle distribution within the solid. The planar approach assumes a particular distribution function for particle arrangement in the slip plane, and then extrapolates this function to particle distribution within the solid. The volumetric approach considers the nature of the distribution in three dimensions, and from this determines the second phase distribution within a slip plane. Equations are derived for each model. A third model, involving the cutting of dislocation loops by other dislocations, is similarly treated, but the final equation is left in terms of general parameters. It was concluded that the volumetric approach is a more accurate representation of actual physical distribution of dispersed phase particles. M.G.J.

N65-33794# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
INVESTIGATION IN THE FABRICATION OF SILICON CARBIDE PNPN SWITCH Interim Engineering Report, 1 Nov. 1964–31 Jan. 1965

H. C. Chang, D. L. Barrett, J. C. Castle, L. J. Kroko, E. H. Myers et al [1965] 47 p refs
(Contract AF 33(615)-1440)
(IER-3; AD-463711)

High purity silicon carbide n-type crystals have been grown for PNPN device fabrication. Current problems of material evaluation are described. Epitaxial growth by the technique of vapor transport has been accomplished. An optimum growth rate for SiC epitaxial growth by thermal reduction has been determined. Aluminum diffusion for the formation of p-type base layers has begun. An npn structure has been realized but not fully evaluated. Tungsten plating experiments for the prevention of oxidation of the tungsten backing plates in a 600° C air ambient are described. Author

N65-33858*# AVCO-Everett Research Lab., Everett, Mass.
MAGNETIC RADIATION SHIELDING SYSTEMS ANALYSIS. SUPERCONDUCTING COIL TECHNOLOGY
R. E. Bernert and Z. J. J. Stekly Jul. 1964 20 p refs Presented at the Electromagnetic Shielding Conf., NASA, Marshall Space Flight Center, Huntsville, Ala., 27 Jan. 1964
(Contract NAS8-5278)
(NASA-CR-64915; AMP-134) CFSTI: HC $1.00/MF $0.50 CSCL 20L

The feasibility of superconducting magnetic radiation shielding, and superconducting coil technology were discussed at an electromagnetic shielding conference. The analytical approach taken in investigating different magnetic field configurations as possible shield geometries, and in determining the shielding effectiveness and system mass of each configuration is summarized. Preliminary results indicate that the magnetic shield approach could be promising for shielding levels above 200 MeV. In reviewing superconducting coil technology, it was pointed out that large high field strength magnets have not been built. Efforts to advance the state-of-the-art are proceeding with theoretical and experimental studies of both wire and strip materials, emphasis is on the determination of the properties of superconducting materials, and superconducting coil behavior. The properties of Nb–Zr strip were studied, and a coil was constructed from the material; figures depict the findings. M.G.J.

N65-33868*# AVCO-Everett Research Lab., Everett, Mass.
EXPERIMENTAL INVESTIGATION OF ADVANCED SUPERCONDUCTING MAGNETS. SUPERCONDUCTING STRIP AND ITS USE IN MAGNETS Final Report
Ethan Hoag Sep. 1964 97 p refs
(Contract NAS8-5279)
(NASA-CR-67016) CFSTI: HC $3.00/MF $0.75 CSCL 20L

An experimental investigation has been carried out to study the characteristics of superconducting strip in the context of its use for practical superconducting magnet construction. Particular attention has been directed toward such practical aspects as superconducting to normal joints, superconducting to superconducting joints, critical current characteristics of wide samples suitable for large coil construction, current density distribution, and heat treatment. A strip coil using approximately 6.8 kg of Nb 25% Zr strip was constructed in order to test the actual applications of the principles learned. The coil incorporated many of these and performed satisfactorily, but did not perform as well as an equivalent wire coil. The study has been broad and exploratory in nature and a considerable portion of the effort has been expended in developing the necessary tooling and measurement techniques. Author

N65-33945# Instituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
THE MEASUREMENT OF THE COMPLEX DIELECTRIC CONSTANTS IN SOLIDS AT MICROWAVE FREQUENCIES BY MEANS OF RESONANCE CAVITIES (A REVIEW) [RICHIAMI SULLA MISURA DELLA CONSTANTE DIELETRICA COMPLESSA NEI SOLIDI ALLA FREQUENZA DELLE MICROONDE MEDIANTE CAVITA RISONANTI (RASSEGNA)]
M. Grandolfo and P. L. Indovina 10 Mar. 1965 60 p refs In ITALIAN; ENGLISH summary
(ISS-65/6) CFSTI: HC $3.00/MF $0.50

The present paper aims at reviewing some methods for the measurement of the complex dielectric constant in solids by means of resonance cavities at microwave frequencies. As an introduction to the explanation of the experimental methods, the main results of the classical theory of the dielectric constants are presented, especially in relation to information of the atomic nature deduced from it. In this survey the importance of these measurements is stressed with reference to information on the properties of polarization of the molecules, and the point-defects present in solids. Author

N65-33996# Picatinny Arsenal, Dover, N. J. Nuclear Engineering Directorate.
LABORATORY EXPERIMENTAL ANALYSIS OF GAMMA RADIATION EFFECTS ON SILICON ALLOY JUNCTION SEMICONDUCTOR DIODES
Burton V. Frank May 1965 149 p refs
(PA-TM-1633; SMUPA-TK-935; AD-618688)

The behavior of silicon diodes of the alloy-junction type is examined, during and following gamma irradiation, in terms of basic diode theory and radiation induced effects in bulk semiconductor materials. Some twenty-seven IN4838 Diodes are exposed to a constant gamma dose rate of 1×10^6 roentgens per hour from a 9,110 curie Cobalt 60 source under constant geometry test conditions. Measurements are made at various gamma dose levels ranging up to 1.67×10^8 roentgens, corresponding to an irradiation exposure time of 167 hours. As was expected, the change in the reverse diode characteristics is significant, whereas there is negligible change observed in the forward diode characteristics. Correlation between the semiquantitative predictions from diode theory and actual experimental data indicate that the transient effects of gamma radiation on silicon diodes are relatively predictable. The procedure for predicting the ionization current is summarized. Diode post-irradiation recovery measurements, under reverse bias conditions, show that the diode is directly affected by the exposed gamma dose. Author

N65-34038# Hughes Aircraft Co., Culver City, Calif. Electronic Properties Information Center.
OPTICAL PROPERTIES AND THERMAL CONDUCTIVITY OF ALUMINUM OXIDE
M. Neuberger Feb. 1965 62 p refs
(Contract AF 33(615)-2460)
(EPIC-S-6; AD-464823)

Graphical and tabular data on the absorption, transmission, reflectivity and refractive index as well as thermal conductivity of aluminum oxide are presented here. The data are principally for single crystal corundum, ruby and sapphire, and the widest range of parameters available in the literature are given.

Author

N65-34052# Texas Instruments, Inc., Dallas.
ORGANIC MATERIALS FOR ELECTRONIC APPLICATIONS Fifth Interim Technical Report, 1 Feb.–30 Apr. 1965
Bernard G. Carbajal III, Rowland E. Johnson, and R. C. Sangster [1965] 23 p
(Contract AF 33(615)-1364)
(TI-08-65-70; AD-616900)

Glow-discharge polymerized (GDP) thin films have been successfully applied as thin insulating layers on magnetic memory planes. Dielectric evaluation studies, including the determination of dielectric constant, refractive index, resistivity, and elevated temperature storage, have been initiated on GDP styrene deposited on glass substrates. Several variations in the conditions of formation of GDP styrene have been included. Author

N65-34084# Linde Co., Indianapolis, Ind. Speedway Labs.
CZOCHRALSKI GROWTH OF $LaAlO_3$ Final Report, Jan.–May 1965
C. D. Brandle 9 Jul. 1965 26 p
(Contract Nonr-4793(00); ARPA Order 306; Proj. Defender)
(SRCR-65-4; AD-617957)

The objective of this program was to explore the possibility of growing high optical quality $LaAlO_3$ by the Czochralski method. The techniques developed for ruby growth were found to be directly translatable to $LaAlO_3$ with no apparent limitations imposed by the use of a crucible. Undoped and doped (Cr^{3+}, Eu^{3+}) crystals of various orientations were grown. Two major defects were encountered: color centers and twinning. Color centers were eliminated by using high purity starting materials in combination with selected growth and post-growth treatment. Two mechanisms for forming color centers are proposed and their relation to $LaAlO_3$ defect chemistry is discussed. The dominant twin planes have been identified to be those of the (100) system. Their relation to the crystal structure of $LaAlO_3$ has been elucidated. Isolated attempts were made to grow $BiAlO_3$ and $PrAlO_3$ to determine if twinning might be a problem in these potential host compositions; other growth problems were encountered indicating that an answer could be obtained only by an extensive effort beyond the bounds of the present program. Author

N65-34095 Naval Ordnance Lab., Corona, Calif. Electricity and Magnetism Div.
FERROMAGNETIC RESEARCH. MAGNETIC FILM STABILITY
R. W. Sharp, R. L. King, and P. C. Archibald *In its* Foundational Res. Proj. 1 Jun. 1965 p 9–12 (See N65-34093 22-34)

A film deposition program based on the use of a self-accelerated electron beam gun to heat the source material, which is supported by a water-cooled, oxygen-free, high-conductivity copper hearth is described. Also, films deposited about ten years ago on standard microscope slides and stored in paper envelopes, were evaluated. The data obtained are presented in tabular form, and the over-all accuracy of the H_c measurements is about ±15 percent. C.T.C.

N65-34098 Naval Ordnance Lab., Corona, Calif. Infrared Div.
SEMICONDUCTOR PHYSICS. EFFECT OF INTERNAL REFLECTION ON FARADAY ROTATION MEASUREMENTS
H. Piller and C. J. Gabriel *In its* Foundational Res. Proj. 1 Jun. 1965 p 27–45 refs (See N65-34093 22-34)

The effect of internal reflection on Faraday rotation was calculated by two techniques of measurement. It is limited to sufficiently high frequencies and to thicknesses where interference effects are negligible. There are different correction terms for these two techniques, which are nearly equal for small angles but quite different for large rotations. In order to make precise measurements of rotation, one should use samples under conditions where these effects can be shown as negligible. In semiconductors with $n \leq 3.7$ it is generally sufficient to fulfill the condition $\eta d \geq 1$ in order to make measurements with a systematic error of less than 2.5 percent. In thin films, however, it is difficult to fulfill this condition, which means that there is a large change in the rotation due to internal reflection, especially with increasing wavelength. Some recent measurements of the effective mass in GaAs, by means of Faraday rotation and Hall effect, showed deviations which were unexplained by theory. Author

N65-34110# Mithras, Inc., Cambridge, Mass.
RESONANT HARMONIC GENERATION AND NON-LINEAR OPTICS Scientific Report, 1 Oct. 1964–31 Mar. 1965
[1965] 29 p refs
(Contract AF 49(638)-1464)
(MC-63-96SR; AFOSR-65-0727; AD-617960)

This report sketches the basic theory of optical second harmonic generation in sufficient generality to include materials with absorption at the fundamental, the second harmonic, or both. It is shown how such absorptions can result in enlarged values of the coefficient of second harmonic generation. The effects of the basic light propagation properties of the material as they contribute to the overall production of second harmonic radiation are further developed. In particular, a discussion is given of the relations between the elements of the second harmonic generation tensor, and the relations between these coefficients appropriate to the crystals of interest in this study. Author

N65-34122# General Electric Co., Schenectady, N. Y. Research Lab.
RESEARCH TO INVESTIGATE THE MICROSTRUCTURE OF THE INTERNAL MAGNETIC FIELD IN SELECTED MAGNETIC MATERIALS Progress Report No. 4, 11 Nov. 1965–10 Feb. 1965
C. D. Graham, Jr. and I. S. Jacobs Feb. 1965 15 p refs
(Contract AF 33(615)-1490)
(Rept.-65-GC-0302M; AD-463559)

Continued research designed to investigate the microstructure of the internal magnetic field in selected magnetic materials is reported. Data are presented in the following areas: solid-state electrolysis of Gd; antiferromagnetism of $CoCl_2$; and hysteretic behavior in metamagnetic transitions. S.C.W.

N65-34125# Istituto Superiore di Sanità, Rome (Italy). Laboratori di Fisica.
A MICROWAVE BENCH FOR MEASUREMENTS OF COMPLEX DIELECTRIC CONSTANTS IN SOLIDS IN THE RANGE OF MILLIMETRIC WAVELENGTHS [UN BANCO A MICROONDE PER MISURE DI COSTANTE DIELETTRICA COMPLESSA NEI SOLIDI OPERANTE NELLA REGIONE DELLE ONDE MILLIMETRICHE]
M. Grandolfo and P. L. Indovina 10 Mar. 1965 54 p refs In ITALIAN, ENGLISH summary
(ISS-65/7) CFSTI: HC $3.00/MF $0.50

This report shows the results obtained in the measurements of the Q-factor of some resonant cavities in the frequency range from 26 to 40 kmc/s. Measurements were carried out by plotting the vsw R versus the frequency near the resonance frequencies of the cavities. The detection of the microwave signal is carried out by a spectrum analyser, an electronic instrument that incorporates a narrow-band superheterodine receiver. Two appendices deal respectively with the problems of the principles of spectrum analyser and of the frequency stabilization of a klystron. Author

N65-34165# Soreq Research Establishment, Israel Atomic Energy Commission, Yavneh.
COVALENCY EFFECTS IN TRIGONAL DISTORTION Scientific Report No. 1
Robert Englman May 1965 26 p refs
(Contract AF 61(052)-806)
(AFCRL-65-592; AD-619881) CFSTI: HC $2.00/MF $0.50

The strength of the axial field, as derived from the splittings of the optical bands of paramagnetic metal ions in crystals of trigonal symmetry, fluctuates greatly from band to band. A qualitative explanation of the effect may be given by assuming that, in addition to the (mostly) positive trigonal field splitting parameter acting at the metal ions, there is also a larger and negative trigonal field splitting parameter acting on the molecular orbitals formed from the ligand orbitals. Covalency mixing results in an *effective* splitting parameter that differs for each configuration (in the t^3 and e^2 subshell,): t^2e or te^2, $t\bar{t}$, $t^2\bar{t}$, te and t^2, written in the order of algebraically increasing splitting parameter. Of equivalent configurations, the one possessing greater interelectronic interaction energy is likely to have smaller covalency coupling and consequently the more positive trigonal field splitting parameter. These findings agree with the empirical data qualitatively; however, the quantitative agreement is insufficient. Author

N65-34231*# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
DEVELOPMENT AND EVALUATION OF MAGNETIC AND ELECTRICAL MATERIALS CAPABLE OF OPERATING IN THE 800° TO 1600°F TEMPERATURE RANGE First Quarterly Report, Nov. 12, 1964–Feb. 28, 1965
P. E. Kueser et al Mar. 1965 134 p refs
(Contract NAS3-6465)
(NASA-CR-54354; WAED-65.17E) CFSTI: HC $4.00/MF $1.00 CSCL 20L

Program I is directed at developing high-temperature magnetic material with satisfactory strength for rotor use. The ternary alloy systems of cobalt-nickel-iron are under study with the cobalt and iron corners of the phase diagram. Thirty to forty percent cobalt gives the greatest saturation at 600° C. The additions of beryllium to a composition of 15% nickel-25% cobalt-balance iron improves the stability of the alpha phase. Eighteen pre-alloyed atomized powders and 12 composite powders have been examined for use as dispersion-strengthened magnetic materials. Program II will determine the feasibility of a high-temperature capacitor using high quality dielectric materials. Program III incorporates combinations of materials into a stator with bore seal, a transformer, and a solenoid for investigations of compatibility under electrical stress and space-simulated conditions of elevated temperature. A system for loading and sealing alkali-metals in vacuum is in the progress of assembly. The stator, transformer and solenoid designs for use in space-simulated testing have been completed. Author

N65-34259# HP Associates, Palo Alto, Calif.
SEMICONDUCTOR OPTOELECTRONIC PHENOMENA INVESTIGATION Interim Engineering Report No. 2, 1 Apr.–30 Jun. 1965
[1965] 100 p refs
(Contract AF 33(615)-2388)
(IER-2, AD-468256)

The dependence of diffusion parameters and the quantum efficiency of the resulting diodes on junction depth, substrate doping, diffusion temperature, Zn concentration in the source and the use of protective evaporated silica surface films was determined. A simple theory accounts for the experimentally observed dependences. For diffusion through thin silica films the junction depth–time dependence is x_j^2/t = constant in agreement with theory. Without the protective layer $x_j/t \approx$ constant which fact is attributed to the build-up of Zn surface concentration with time. The study of photoconductivity in Zn-doped silicon has included the development of a Zn diffusion technique for controllably doping Si uniformly and the measurement of the resulting resistivities, photoconductive gains and electron lifetimes for illumination with GaAs el diodes. Also a theoretical analysis of the phenomenon was undertaken and is presented. Lifetimes up to 0.7 ms and dark to light resistivity ratios of 130 have been obtained. Author

N65-34307# California Univ., Livermore. Lawrence Radiation Lab.
THE STABILITY OF AVALANCHE TRANSISTORS
Phillip E. Allen [1965] 37 p refs
(Contract W-7405-ENG-48)
(UCRL-14210-T)

Analyses of the physical characteristics of avalanche transistors indicate that stability depends primarily on avalanche breakdown, avalanche current, and sustaining voltage. Breakdown voltage increases with temperature rise due to increased conductivity and decreased impurity density. Avalanche current is reduced with increases in temperature and emitter efficiency. Sustaining voltage decreases as emitter efficiency and resistivity decrease; voltage does not change significantly with rises in temperature because emitter efficiency and resistivity cancel each other out with temperature increases. A stability problem presented centers on the tendency of I_A to drift downward with use, and it is proposed that this drift is due to minor dislocations caused by the formation of mesoplasmas near or in the surface states. Catastrophic behavior is attributed to heating of the surface layer which causes it to change states and to develop a new lower voltage, low current, breakdown mode. A method is proposed for detecting the transistors that would exhibit such behavior. M.W.R.

N65-34308# Oak Ridge National Lab., Tenn. Metals and Ceramic Div.
METHODS OF ANALYSIS FOR LOCALLY-ORDERED ARRANGEMENTS AND ATOMIC DISPLACEMENTS BY X-RAY DIFFRACTION
C. J. Sparks and B. Borie 22 Apr. 1965 47 p refs Submitted for Publication
(Contract W-7405-ENG-26)
(ORNL-P-1240; CONF-650203-8)

The X-ray diffraction method for determining the local arrangement of the atoms in a solid solution is discussed theoretically and in terms of laboratory procedures. The Warren theory is followed, since it is most applicable to quantitative interpretation. Experiments indicate that because the volume element takes on a very elongated shape perpendicular to the plane of the incident and diffracted beams at low 2θ the reciprocal lattice near the origin is inaccessible. It is concluded that data near the reciprocal lattice points should be treated with suspicion unless extreme caution is taken to eliminate all stray radiation outside the intended volume element. G.A.L.

N65-34313# Iowa State Univ. of Science and Technology, Ames. Ames Lab.
THE EFFECT OF PRESSURE ON F CENTER LUMINESCENCE
Alfred Douglas Brothers, Jr. (M.S. Thesis) May 1965 36 p refs
(Contract W-7405-ENG-82)
(IS-T-10)

Measurements of the pressure shift of the peak energy of the F emission spectra of KBr, KCl, and KI crystals additively

colored with potassium have been made. The values obtained were 1.89×10^{-5} eV/atm, 2.25×10^{-5}eV/atm, and 2.07×10^{-5} eV/atm respectively. The peak energy shift of M emission in KBr and R emission in KCl have also been determined to be 2.54×10^{-5}eV/atm and 1.20×10^{-5}eV/atm respectively. A pressure induced splitting of the F emission band of KBr into two components, 0.02 eV apart, has been observed. The higher energy component grows with pressure until at 50,000 psi it appears equal in magnitude to the original single peak present at atmospheric pressure. A substantial increase in halfwidth with pressure in KBr and KI, from 0.215 eV to 0.260 eV and from 0.160 eV to 0.216 eV respectively, with increasing pressure to 57,500 psi was noted. Possible relations between the increased halfwidths and the appearance of the new emission component are suggested. Author

N65-34321# Washington Univ., Seattle.
THE EFFECT OF VARIOUS TREATMENTS ON THE THERMOLUMINESCENCE OF LITHIUM FLUORIDE EXPOSED TO LOW DOSES OF GAMMA RADIATION
Charles Ross Watson (Ph.D. Thesis) 1965 42 p refs
(Contract AT(45-1)-540)
(TID-21945)

Variables affecting the response of lithium fluoride exposed to low doses of gamma radiation are considered in a study of thermoluminescent dosimetry systems. Treatment methods investigated—annealing with slow cooling, annealing with rapid cooling, and reuse after sieving—were compared with no treatment at all, which yielded the most sensitive measurement of 580 mr. It is concluded that if lithium fluoride is to be used for measuring low doses, the phosphor should be reused without treatment; larger doses require annealing to remove residual thermoluminescence. Annealing with a slow cooling is found to be the best method of lowering background reading and restoring the lithium fluoride to give consistent response; this treatment is also applicable in cases where repeated calibrations are impractical. Annealing with rapid cooling which lowers background but does not give the consistency of response of slow cooling, is considered valuable when available treatment time is minimal and it's possible to calibrate each bath of lithium fluoride. Sieving is unacceptable because of erratic response and large standard deviation of reading. M.W.R.

N65-34394*# Massachusetts Inst. of Tech., Cambridge. Center for Space Research
THERMAL AND ELECTRONIC TRANSPORT PROPERTIES OF ZINC ANTIMONIDE Scientific Report No. 1
Paul John Shaver 20 Apr. 1965 188 p refs
(Grant NsG-496)
(NASA-CR-67081) CFSTI: HC $5.00/MF $1.25 CSCL 20L

The preparation of single crystals of p-type ZnSb is described. A horizontal zone recrystallization method was used with an antimony rich molten zone. Argon gas was added to the sealed growth ampoule to suppress decomposition during crystal growth. Copper doping was used to control the hole concentration. Doping with Al, Se, or In failed to produce n-type ZnSb. Methods are described for making electrical and thermal contacts to this material. A reversible increase in the hole concentration of undoped, p-type crystals was found to occur under annealing at elevated temperatures (60° C to 240° C) in inert atmospheres. With storage at room temperature, the hole concentration was found to relax towards the pre-annealing hole concentration. A plausible explanation is advanced for this phenomenon. The experimentally observed results of the galvanomagnetic measurements are shown to be in excellent agreement with a model for the valence band conduction processes which assumes that: a single general ellipsoid describes surfaces of constant energy in reciprocal space and that the relaxation time is either a scalar function of energy or a tensor of constants with a factorable energy dependence. Author

N65-34444# Rensselaer Polytechnic Inst., Troy, N. Y.
INVESTIGATION OF TRANSIENT RADIATION DAMAGE IN SEMICONDUCTOR MATERIALS Quarterly Progress Report, 1 Aug.–31 Oct. 1964
Roland M. Lichtenstein [1964] 16 p
(Contracts DA-36-039-AMC-02165(E))
(QPR-7; AD-618495)

During this quarter a more reliable method of single pulsing the linac was developed and is described. Modifications to the strobolight circuits are described which will provide a more reliable single light pulse source for use in the target room. A small amount of data is shown, but the light source had not yet been completely modified when this data was taken. Author

N65-34454# Pennsylvania Univ., Philadelphia. Dept. of Physics.
ON THE ANISOTROPY OF EXCHANGE IN YTTERBIUM IRON GARNET
Peter M. Levy Jul. 1965 8 p refs
(Contract Nonr-551(36))
(TR-24; AD-618038)

The exchange splittings of the lowest $^2F_{5/2}$ and $^2F_{7/2}$ doublets of Yb^{3+} in YbIG in terms of the exchange potential parameters were evaluated. Wave functions were obtained by fitting to the g-values of these doublets in YbGaG. Other functions were obtained by fitting to energy levels of the $^2F_{5/2}$ state of Yb^{3+} in YbGaG, and to the g-values of both doublets. It was shown that the two sets of wave functions differ appreciably. A good four parameter fit of the experimental exchange splittings is obtained by adopting essentially zero values for the rare-earth-iron exchange interactions that take place through the nearest neighbor oxygen ions. The chief result of this analysis is that the RE-Fe exchange interaction takes place primarily through the next-nearest neighbor oxygens (2.43Å); the nearest neighbor oxygens are comparatively inert. It was concluded that in contradistinction to the 3d-transition element ions, the exchange interactions involving 4f-rare-earth ions may be highly anisotropic. This is due to their large spin-orbit couplings, and relatively small crystalline fields. R.W.H.

N65-34464*# Radio Corp. of America, Camden, N. J. Applied Research Dept.
STUDY OF PROPERTIES OF HIGH-FIELD SUPERCONDUCTORS AT ELEVATED TEMPERATURES Technical Summary Report, 21 Jun. 1964–21 Jun. 1965
R. Hecht and C. M. Harper 26 Jul. 1965 37 p refs
(Contract NAS8-11272)
(NASA-CR-67157) CFSTI: HC $2.00/MF $0.50 CSCL 20L

An experimental program to study the current-carrying capacity of high-field superconductors at elevated temperatures is described. Currents are induced in the windings of shorted NbZr and Nb_3Sn coils, or in the walls of NbZr, Nb_3Sn and NbTi tubes, by applying a magnetic field parallel to the sample axis. The critical current density, J_c, is then found to depend on temperature, applied field (applied field sweep rate) and on the defect structure of the superconductor. It is found that various mechanisms will trigger the sudden revision of a sample to the normal state, (flux jump), but that a particular mechanism will dominate in a given sample under given experimental conditions. Author

N65-34473# Korad Corp., Santa Monica, Calif.
INORGANIC LASER MATERIALS Interim Engineering Report, 1 Dec. 1964–31 Mar. 1965
Wright-Patterson AFB, Ohio, AF Avionics Lab., 15 Apr. 1965 49 p refs
(Contract AF 33(615)-1967)
(AD-466008)

Laser operation was achieved with two unary oxides (Gd_2O_3 and La_2O_3) doped with Nd^{+3} and emphasis is being placed on improvement of crystal quality and performance efficiency of these hosts, as well as the extension of this work to other primary additives. A study was undertaken of multiple doping effects (sensitized fluorescence), with emphasis on the system $Er^{+3} \rightarrow Tm^{+3}$. Since the effect of the Er^{+3} enhancement on Tm^{+3} fluorescence was found to increase with Er^{+3} concentration, it was decided to proceed to the limiting case where the entire host lattice acts as a sensitizer. Crystal growth of this system was initiated, and pulsed and continuous wave laser operation of this material was achieved. In the case of binary oxides, theoretical and experimental research is being conducted to evaluate $GdAlO_3$, $MgO–Al_2O_3$, and $BeO–Al_2O_3$ as laser hosts. A simultaneous study of hybridized growth techniques is accompanying this activity to cope with the manifold problems associated with crystal growth of polynary oxides. R.N.A.

N65-34496# University Coll., Cardiff (Wales). Dept. of Applied Mechanics.
RESEARCH ON RECOMBINATION THEORY IN SEMICONDUCTORS Scientific Summary Report No. 2, 1 May 1964–30 Apr. 1965
D. A. Evans, P. T. Landsberg, and E. E. Smith 31 May 1965 8 p refs
(Contract AF 61(052)-664)
(AFCRL-65-476; AD-619162)

Theory of decay of excess carrier concentrations, auger recombination in traps, radiative cascade theory, and phonon cascade are discussed in a review of research on recombination theory in semiconductors. A solution is evolved for the determination of auger recombination in traps, and a cascade model is set up which provides guidelines for a cascade theory incorporating the effect of phonons and of electron collisions. M.W.P.

N65-34497# Army Electronics Labs., Fort Monmouth, N. J.
SUBSIDIARY RESONANCE IN PLANAR HEXAGONAL FERRITES
Maurice Weiner and Samuel Dixon, Jr. Jun. 1965 13 p refs
(ECOM-2598; AD-620081)

Subsidiary resonance phenomena in single-crystal ZnY and Mn–ZnY have been theoretically and experimentally investigated. Using a general expression for the first-order spin-wave instability, the threshold fields for pump frequencies above the characteristic frequency (ω_c) are calculated for various ratios of ω/ω_m, and $\omega/\gamma H_s$. Good agreement is shown between experimental data and theoretical predictions. Author

N65-34688# Sperry Rand Research Center, Sudbury, Mass.
INVESTIGATION OF THE ELECTRICAL AND OPTICAL PROPERTIES OF JUNCTIONS IN VAPOR-DEPOSITED COMPOUND SEMICONDUCTORS Final Report, 1 Jun. 1964–31 May 1965
Henry T. Minden Jun. 1965 34 p refs
(Contract AF 19(628)-4189)
(SRRC-RR-65-52; AFCRL-65-498; AD-619717)

Germanium was epitaxially deposited on gallium arsenide by means of the hydrogen reduction of $GeCl_4$. Above 800°, germanium reacted with the GaAs seed to form a black powder. Proper deposition was observed below about 750°. Nonetheless, cross doping of the Ge layer by gallium was observed even at deposition temperatures as low as 670°; the heterojunctions showed tunnel diode characteristics. Deliberately doped junctions of p-Ge on n-GaAs showed the I-V characteristics of Ge junctions, while the photovoltaic response was that of a GaAs junction. The voltage sign of the response was that of normal p-n junctions. An apparatus is described for the epitaxial deposition of GaAs. The conditions for the preparation of high-purity, smooth layers are described, and doping techniques are given. Epitaxial lasers were made by the deposition of zinc-doped epitaxial layers on n-type GaAs substrates. Junctions diffused into high-purity layers showed low-leakage currents, and some negative resistance characteristics were observed. Author

N65-34697*# North Carolina State Coll., Raleigh. Dept. of Engineering Research.
TABLES OF $F(U_s, U_b)$ AND $G(U_s, U_b)$ FUNCTIONS FOR SEMICONDUCTOR SURFACE CALCULATIONS
R. J. Mattauch, R. W. Lade, and G. B. Hoadley [1963] 77 p refs *Its* Bull. No. 80 Sponsored in part by NASA
(Grant NsG-588)
(NASA-CR-67169) CFSTI: HC $3.00/MF $0.75 CSCL 20L

Mathematical functions, necessary for calculating the change in surface conductance of a semiconductor due to an applied charge, are derived and evaluated. These functions are presented in tabular form. R.N.A.

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N65-33662* Texas A&M Univ., College Station.
CHARACTERISTICS OF SOLID PROPELLANT OXIDIZER SUSPENSIONS
P. T. Eubank and B. F. Fort *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 3 p ref (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

Shear stress and pressure drop data, from a viscometer and pipe apparatus respectively, for aqueous solutions of polyvinyl alcohol (PVA) and sodium carboxylmethylcellulose (CMC) polymers were measured at 25°C to evaluate the relative merit of three numerical integration procedures that convert viscometric data to pipe data without the occurrence of errors greater than 4% for all pseudoplastic, time-independent liquids. The integration procedures are stated. An improvement was made in the rotational viscometer allowing readings to be taken at any intermediate angular velocity of the bob. The original unit was limited to eight fixed speeds. In addition, both the rotational and pipe apparatus were revised for data procurement over the temperature range 25°C to 100°C. A constant temperature bath was constructed around the rotational viscometer, and the pipe apparatus kettle and tubes were jacketed for hot water. L.S.

N65-33889# Stanford Research Inst., Menlo Park, Calif.
HIGH ENERGY OXIDIZERS IN SOLUTION Technical Progress Report No. 1 (Annual), Jul. 1, 1964–May 15, 1965

W. E. Tolberg, R. S. Stringham, R. T. Rewick, and M. E. Hill
15 Aug. 1965 29 p refs
(Contract AF 04(611)-9370; ARPA Order 24)
(AFRPL-TR-65-131; AD-468318)

The solubilities of NF_3 and F_2 have been measured at several temperatures as a function of their pressures over liquid HF. The systems follow Henry's Law, p = kX. When the partial pressure of the gas is in cm of Hg and X is the mole fraction in solution, $k(NF_3) = 0.760 \times 10^5$ cm at 0° C, and the differential heat of solution from −77.2 to 20° C is 1620 calories per mole. For fluorine, $k(F_2) = 1.740 \times 10^5$ cm at 0° C, and the differential heat of solution from −77.2° to 0° C is 582 calories per mole. Above 0°, the fluorine solubility goes through an inflection, the solubility being only slightly greater at 20° C. The F^{19} NMR spectra of the HF/SbF_5 system became resolved at a temperature just above the freezing point of the mixture: the resonance lines and their intensity ratios and splittings were consistent with the previously unreported complex ion, $Sb_2F_{11}^-$. The F^{19} resonance lines of NF_3 and F_2 dissolved in HF have the same chemical shift as that observed in the gas phase. Author

N65-34007*# Martin Co., Denver, Colo.
STUDY OF CONTAMINATION OF LIQUID OXYGEN BY GASEOUS NITROGEN Final Report
Dade A. Fester, Philip J. Pizzolato, and John R. Wilde Jul. 1965 345 p refs
(Contract NAS8-11337)
(NASA-CR-64967; Martin-CR-65-44) CFSTI: HC $7.00/MF $1.75 CSCL 21I

A specially-designed test fixture was used in an experimental program dealing with the contamination of liquid oxygen by gaseous nitrogen. Runs were made in both cylindrical and spherical LOX tanks, and both cycling and constant tank pressures were investigated over the range from 19 to 5000 psia. Other parameters considered are LOX temperature, liquid-gas volume ratio and interfacial area, gaseous nitrogen inlet temperature, exposure time, and tank geometry. A computer program was developed for the analytical model for the system. M.W.R.

N65-34036# Aerojet-General Corp., Downey, Calif. Research Div.
LARGE SOLID PROPELLANT BOOSTERS EXPLOSIVE HAZARDS STUDY PROGRAM Quarterly Progress Report No. 3, Oct. 1–Dec. 31, 1964
O. R. Irwin, G. L. Roark, and P. K. Salzman 27 Jan. 1965 48 p refs
(Contract AF 04(611)-9945)
(Rppt.-0866-01(03)QP; AD-464837)

The explosive hazards associated with large solid propellant boosters were examined to determine the critical diameter of typical class II propellants, and to extend the critical diameter concept to other grain configurations as well. Critical diameter and critical geometry studies determine under what donor intensity, configuration, and location partial or complete detonation can occur. A simple theoretical model of the detonation process in RDX adulterated AP-PBAN propellant was developed. Three new batches of RDX wax explosive for the critical geometry were cast. Fifty-six critical geometry tests were performed, and circular, square, triangular, and rectangular cross-sections were evaluated as well as circular core cylinders. W.M.R.

N65-34151# California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials.
A RESEARCH PROGRAM ON SOLID PROPELLANT PHYSICAL BEHAVIOR Quarterly Reports Nos. 5 and 6, 1 Feb.–31 Jul. 1965
Aug. 1965 16 p refs
(Contract AF 04(611)-9572)
(MATSCIT-PS-65-4; AD-619699)

Microscopic theory of gum rubber failure and factorization of nonlinear viscoelasticity to constant load creep data are applied to the mechanical behavior of gum rubber vulcanizates. To test the failure theory, average stretch ratio is calculated and used in data reduction. For a viscoelastic body the time dependence of the shear modulus is factored from the time dependence of the stretch ratio, and creep data is plotted for enough different load levels to cover the range of break times up to 2000 min. At each instant the material behavior is shown to be essentially Mooney–Rivlinear; there is a marked deviation from linearity for strain less than 20% and the start of the usual upswing for stretches in excess of five. Standardized material characterizations studies deal with a Solithane system, an experimental resin, and Telagen CT. Computer programs are being developed in the area of material properties interconversions. M.W.R.

N65-34174# Mathematical Sciences Corp., Seattle, Wash.
PARAMETRIC STUDY OF ROCKET GRAIN CONFIGURATIONS BY PHOTOELASTIC ANALYSIS Quarterly Progress Report No. 2, 1 May–31 Jul. 1965
R. R. Parmerter and M. E. Fourney 1 Aug. 1965 36 p refs
(Contract AF 04(611)-10529)
(MSC-65-29-6; AD-619900)

Parametric photoelastic investigations were conducted on two families of star grains. The dependency of the maximum stress on the various geometric parameters has been established and is presented in graphical form. A limited investigation was made on the dependency on N, the number of star points. Results for the positive wedge angle family of grains were obtained. It is shown that the maximum stress is reduced as N, or the wedge angle is increased. On the other hand an increase in the value of the port fraction or the fillet radius factor tends to increase the maximum stress. Typical applications of the results are given in an appendix. TAB

N65-34420# Rohm and Haas Co., Huntsville, Ala. Redstone Arsenal Research Div.
A MICROWAVE TECHNIQUE FOR STUDYING DETONATION PHENOMENA
Edgar G. Johnson 13 Sep. 1965 25 p refs
(Contract DA-01-021-ORD-11909(Z))
(S-87; AD-469632)

The microwave energy reflected by the shock front has been used to determine velocities of both reactive (detonation) and non-reactive shocks. This technique used standard microwave components and an expendable, dielectric rod waveguide as a transmission line to the sample under study. The oscillogram of the output of a crystal detector is a continuous displacement-time trace of the shock front as it moves through the sample. The trace can be interpreted in terms of microwave interferometry, in that the detected signal goes through a maximum and a minimum for each displacement of the shock front by a half wavelength, or as the Doppler shift

in frequency produced by the velocity of the approaching shock front. This technique has been applied to the problem of determining the growth to detonation near the 50% card gap value of 1-inch diameter charges of Composition C-4 explosive and of 2-inch diameter charges of ammonium perchlorate confined in glass. Simultaneous microwave and streak-camera measurements of the detonation of 2-inch diameter charges of pentolite have been made. Author

N65-34550# Bureau of Mines, Pittsburgh, Pa.
SENSITIVITY OF PROPELLANT SYSTEMS Quarterly Report, Apr. 1–Jun. 30, 1965
F. C. Gibson, R. W. Watson, J. E. Hay, C. R. Summers, J. Ribovich et al 30 Jul. 1965 26 p refs
(BuWEPS Order 19-65-8023-Weps)
(QR-3; AD-468490)

Shock sensitivity and detonation characteristics of thin films of Ng-EGDN-TA were tested in a two-dimensional analog of the card-gap test. Gap thicknesses corresponding to the thresholds between the high velocity detonation (HVD) and the low-velocity detonation (LVD), as well as for LVD and no initiation (NI) were determined for 1/32, 1/16, and 1/8-inch thick films. The thresholds between the HVD's and LVD's, and between the LVD's and NI's were appreciable higher for the thicker film. However, the difference is slight at the LVD-NI threshold for a mixture containing 20% TA, and no detonations were obtained with a 22-1/2% TA concentration. Nitromethane detonated in 1/2-inch film thickness at high velocity in one trial. Preliminary experiments with hot wire initiation of deflagration reactions in nitroglycerin were not successful. Attempts to obtain reproducible ignition delays and burning rates with NG-EGDN were made, and hot wire ignition was obtained at pressures above ~ 400 psi. Stability studies of the LVD in liquid systems established a relatively stable detonation rate, but the length of the cavitated region increased monotonically with charge length from three to 12 feet. G.G.

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N65-33716*# National Aeronautics and Space Administration, Washington, D. C.
COMMENTARY ON SPACE PROPULSION ACTIVITIES
A. O. Tischler [1964] 23 p Presented at the Natl. Meeting of the AIAA, 30 Jun. 1964
(NASA-TM-X-51866) CFSTI: HC $1.00/MF $0.50 CSCL 21H

A general commentary on space propulsion activities concludes that the capability "to loft large payloads into space is virtually here." Ability to exploit this capability with self-transporting equipment requires the development of missions beyond the existing Surveyor, Gemini, and Apollo. More sophisticated space propulsion systems, it is concluded, are the key to performance improvement of space programs. M.W.R.

N65-33725# Thiokol Chemical Corp., Brigham City, Utah. Wasatch Div.
WEAPON SYSTEM 133A: STAGE 1 MINUTEMAN MOTORS. EXTENDED R AND D EFFORT, PROGRAM PROGRESS Contract Status Report, 1 Apr.–30 Jun. 1964
27 Aug. 1964 118 p *Its* Pub. No. 864-5476
(Contract AF 33(600)-36514)
(PM-0864-5569; AD-460939)

A 37 month aging was shown on the Minuteman motor assembly, and a shelf-service total life of 60 months is predicted for Wing I configuration. Nozzle plugs are being reworked to eliminate excessive leakage, a nozzle joint seal design was developed, and aft closure segment defects were investigated. Also considered were raw materials storage conditions, liner standardization, and a technique for predicting burning rates of the propellant from X-ray fluorescence. Raw material characterization was conducted in connection with propellant standardization improvement, and a program was initiated to define polymer storage temperature limits. Case propellant removal procedures were evaluated, and a study was made to retard or eliminate case corrosion during reclamation. M.W.R.

N65-33745# Lockheed Propulsion Co., Redlands, Calif.
REPORT ON STATIC TEST OF HYDAC MOTOR (H25-8) ON 27 OCTOBER 1964
L. Cobb 4 Dec. 1964 19 p
(Contract DA-28-043-AMC-00376(E))
(AD-463778)

The results of a static firing test of a Hydac motor, model H25-8, at a propellant grain temperature of 132° F are presented. All motor components performed well during motor operation. The aft end rubber insulation and igniter tube were of special interest because of previous flight malfunctions. Based on a thorough failure analysis of these flight motors and a study of the H22-1 static spin test results, it was determined that the present aft end rubber insulation is marginal under flight conditions. The ballistic data and the hardware evaluation of this test indicate that for flight usage, further improvement of the reliability and performance of this motor is necessary. Three major proposed design changes are discussed. R.N.A.

N65-33884*# Marquardt Corp., Van Nuys, Calif.
DESIGN STUDY AND EVALUATION OF A MULTIFUEL ENGINE FOR A SPACE POWER SYSTEM Final Report, 19 Apr.–4 Jun. 1965
M. Arao and B. R. Chandler 15 Jul. 1965 132 p refs *Its* Rept.-6095
(Contract NAS9-857)
(NASA-CR-64897) CFSTI: HC $4.00/MF $1.00 CSCL 21H

The feasibility, performance, and endurance of a modified hypergolic ignition engine operating on gaseous hydrogen and oxygen was studied. Slight changes in the injector system, and the addition of a starting ignition glow plug were used to modify the original hypergolic engine. The wide range of engine power delivery including overspeed and overload, was demonstrated without damage with propellants at stoichiometric O/F ratios up to 8:1 and high volumetric expansion ratios of from 23:1 to 38:1. A detailed analysis of the propellant flow measurements and flow characteristics, combustion efficiency, indicator and heat rejection, performance improvement tests, and vacuum operation is given. An appendix contains performance comparisons of candidate H_2–O_2 power systems for extended missions in space. G.G.

N65-34000*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AN ANALYSIS OF CHEMICAL UPPER STAGES FOR NASA SCIENTIFIC MISSIONS
Washington, NASA, 1965 121 p refs
(NASA-TM-X-52127) CFSTI: HC $4.00/MF $1.00 CSCL 21H

An analysis of chemical upper stages for advanced scientific missions has been carried out. Development of a cryogenic upper stage, with a propellant capacity near 7000 pounds, can substantially increase the capability of present NASA launch vehicles for advanced scientific missions. Best performance of the configurations investigated is achieved through use of hydrogen–fluorine propellants in a pump-fed stage requiring the development of a new propulsion system. This performance can be closely matched by a hydrogen–oxygen stage using the RL-10A-3-3 engine which more nearly represents current state-of-the-art in cryogenic propellants. A preliminary design of such a stage, having a propellant capacity of 7000 pounds, was carried out. The performance capability of the hydrogen–oxygen upper stage in conjunction with the Atlas–Centaur and the Saturn IB-Centaur launch vehicles was evaluated. Author

N65-34076 Library of Congress, Washington, D. C. Aerospace Technology Div.
COMBUSTION INSTABILITY IN SOLID-PROPELLANT ROCKETS
Paul Vantoch *In its* Foreign Sci. Bull., V. 1, No. 9 Sep. 1965 p 1–29 refs (See N65-34075 22-34)

The present review of open source material related to combustion instability indicates that Soviet researchers emphasize studies of certain physicochemical aspects of solid propellant combustion, such as phase transitions, condensed phase reactions, formation of condensed residues, catalytic and thermal effects of combustion products, and effects of inhomogeneities of the burning surface. Some of these phenomena may be contributing factors in the occurrence of certain instability modes. Possible mechanisms and instability sources are summarized. Author

N65-34229*# Marquardt Corp., Van Nuys, Calif.
THE DESIGN AND PERFORMANCE OF A 3KW CONCENTRIC TUBE RESISTOJET Final Report
R. J. Page and R. A. Short Sep. 1965 74 p refs
(Contract NASw-1070)
(NASA-CR-54410; TMC-25168) CFSTI: HC $3.00/MF $0.75 CSCL 21C

A 3 kw concentric tube resistojet, using hydrogen as a propellant, was designed for operation from solar cell power supplies. A heat exchanger of unique geometry made possible by the tungsten vapor deposition process permitted cool operation and hence longer life for the boron nitride insulators. In a 25-hour performance test in a vacuum, a specific impulse of 828 seconds was measured at an overall total power efficiency of 0.77, using a precision thrust dynamometer. Stagnation chamber conditions of 8.8 atmospheres and 2417°K were measured. High life expectancy and reliability are apparent features of the design. Author

N65-34240*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COLLOID THRUSTOR BEAM ANALYSIS: DESIGN AND OPERATION OF A SUITABLE QUADRUPOLE MASS FILTER
Carl T. Norgren, Daniel S. Goldin, and Denis J. Connolly Washington, NASA Oct. 1965 45 p refs
(NASA-TN-D-3036) CFSTI: HC $2.00/MF $0.50 CSCL 21C

A quadrupole mass filter and a monopole spectrometer were designed and calibrated to be used in the analysis of the beam produced by a colloid thrustor. The mechanical and electrical design of the quadrupole mass filter is presented along with detailed calibration and test data. Only limited calibration data are presented for the monopole spectrometer because absolute transmission proved to be inadequate for the intended application. The quadrupole mass filter was designed for a resolution of 10 (for particles accelerated through a 14 000-V potential), a constant radiofrequency voltage of 1000, and a variable-frequency mode of operation so that an atomic mass unit per unit electron charge range from 10 to 10^9 could be scanned. The quadrupole was calibrated with singly and doubly charged mercury ions accelerated through potentials from 500 to 48 000 volts. It is shown that the beam mass-to-charge distribution can be determined within a maximum quadrupole design error of 7 percent. Use of the quadrupole mass filter to determine the average atomic mass unit per unit electron charge produced by a condensation-colloid thrustor is described, and comparison is made with previous colloid mass determinations obtained from photomicrographs and thrust-and-current measurements. Author

N65-34258# Thiokol Chemical Corp., Huntsville, Ala. Huntsville Div.
INVESTIGATION OF SOLID PROPELLANT ROCKET MOTOR CASES Quarterly Interim Technical Report, 22 Mar.–21 Jun. 1965
D. L. Daigle, E. J. Mc Cool, and R. E. Bradley 30 Jul. 1965 16 p
(Contract DA-01-021-ORD-11919(Z))
(Rept.-342-65; AD-467701)

In view of the recent development of techniques for the fabrication of high strength thin walled metal pressure vessels for use in rocket motor case application, a study was undertaken to determine the influence of defects in the metal on the performance of the pressure vessel. Based on an evaluation of thick sections of maraging steel and cryogenic stretched stainless steel, a decision was made on the size defect to be incorporated in several motor cases to establish the influence of the defect on case performance at −65° F. Presented are results of pressure cycling tests on two cases. Also cited is the development of an improved technique that employs a pressurization medium applied locally in the area of the starter notch to accomplish fatigue growth. S.C.W.

N65-34288# United Technology Center, Sunnyvale, Calif.
FOURTH-STAGE SCOUT ROCKET MOTOR PROGRAM Development Test Report
16 Mar. 1965 102 p refs
(Contract AF 04(695)-588)
(UTC-2100-DTR; AD-464839)

Static firings of eight XSR 57-UT-1 rocket motors were conducted at angular velocities of 0 to 210 rpm. All test objectives were satisfied in seven of the firings, and three of these seven firings were consecutive successes, in accordance with the requirements of the contract. These tests verified the design and structural integrity of the XSR 57-UT-1 rocket motor, demonstrated all operational characteristics, and proved the motor under the various environmental conditions to which it may be subjected. The most significant effect of spinning the motor during static firing was determined to be the deposition of aluminum oxide in the aft cylindrical section of the case. This deposition, in turn, increased the case postfire temperature. Other effects resulting from spinning the motor were an increase in chamber pressure, burning rate, and insulation ablation rates. The areas which were not affected by spinning were the motor ignition delay and the nozzle ablation rates. The incorporation of insulation in the cylindrical section of the motor case is required to maintain the case temperature within the contractual limits. With this modification, the motor is acceptable for preliminary flight rating test. Author

N65-34294# Arde-Portland, Inc., Paramus, N. J.
INVESTIGATION AND FEASIBILITY DEMONSTRATION OF A VARIABLE AREA THROAT NOZZLE SYSTEM Quarterly Progress Report No. 1
25 Aug. 1965 170 p
(Contract AF 04(611)-10749)
(AFRPL-TR-65-146; AD-469791)

This program consists of choosing a nozzle concept for a throttleable, restartable solid rocket motor and to develop and demonstrate this concept through test firings. During this reporting period, an analytical evaluation was performed which resulted in the Subsonic Pintle Nozzle being chosen as the most promising concept. Four annular type nozzles were designed and will be tested to gather specific information required for the design of the development and demonstration nozzles. Author

N65-34398*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AN EXPERIMENTAL CORRELATION OF THE NONREACTIVE PROPERTIES OF INJECTION SCHEMES AND COMBUSTION EFFECTS IN A LIQUID-PROPELLANT ROCKET ENGINE. PART I: THE APPLICATION OF NONREACTIVE-SPRAY PROPERTIES TO ROCKET-MOTOR INJECTOR DESIGN
Jack H. Rupe 15 Jul. 1965 60 p refs
(Contract NAS7-100)
(NASA-CR-67058; JPL-TR-32-255) CFSTI: HC $3.00/MF $0.50 CSCL 21H

The properties of the sprays produced by a pair of unlike impinging streams of nonreactive fluids were utilized as the design basis for a series of eight injectors having distinctively different specifications. Particular emphasis was placed on the use of available information and the development of new techniques, where required, to permit quantitative description of the mass and mixture-ratio distributions produced by each injection scheme. Methods of describing the mass-distribution model of an element are presented in detail, together with the properties of injector orifices, the jets they produce, and the combined flows provided by each injector. This information is being utilized as a basis for correlating injection schemes with combustion phenomena. Author

N65-34447# Space Technology Labs., Inc., Redondo Beach, Calif.
NUCLEAR SPACE MISSIONS: A SELECTED BIBLIOGRAPHY Special Literature Survey No. 9
R. R. Velin and L. R. Magnolia, comp. 7 Sep. 1965 24 p refs
(STL-9990-6998-KU-000)

N65-34470# Thiokol Chemical Corp., Huntsville, Ala.
EVALUATION OF THE LYON, INC. FORTY INCH DIAMETER ROCKET MOTOR CASE FABRICATED BY THE HOT CUP-COLD DRAW PROCESS Phase Report
David L. Daigle 29 Jan. 1965 155 p
(Contract DA-01-021-ORD-11919)
(Rept.-305-65; AD-455918)

A large motor case fabricated from steel by the hot cup-cold draw process underwent pressurization tests at the low temperature of −65° F. Relatively large deviations in case dimensions were noted at the thrust reverser bosses, and in the case wall thickness near the aft P.T., but did not appear to affect the performance under pressure. The case failed in a ductile manner at a biaxial strength level of 274,000 psi. Based on comparison, it appears that the performance of the above described motor case differed little from the performances of the second stage Pershing cases presently being manufactured. G.G.

N65-34521# Aerojet-General Corp., Sacramento, Calif.
ADVANCED PROPELLANT STAGED COMBUSTION FEASIBILITY PROGRAM Quarterly Progress Report No. 1, 1 Jun.–31 Aug. 1965
Robert J. Kuntz, Charles O'Brien, Norman E. Van Huff et al
15 Sep. 1965 153 p refs
(Contract AF 04(611)-10785)
(Rept.-10785-Q-1; AD-470098)

A summary of major accomplishments and a discussion of the technical aspects of a program to define the problems associated with utilization of 98% H_2O_2 and alumizine-43 in a staged combustion rocket engine system are presented. In the engine conceived, all of the H_2O_2 is used to regeneratively cool a secondary combustor (in which alumizine-43 is burned) before passing through the preburner catalyst pack and turbine. The problems associated with operating this engine cycle are the ability to cool the secondary combustor, temperature control of the decomposed peroxide, catalyst integrity (activity, durability) at temperatures up to 2100° F, heat transfer characteristics of 98% peroxide, and the influence of the explosive decomposition characteristics of H_2O_2 vapor on the engine design. It is reported that H_2O_2 metal material compatibility studies, physical property determinations, a literature survey, and the design of hardware has been partially completed. It is also reported that engine designs for two cooled engines, one with an alternative oxidizer, N_2O_4, are complete. C.T.C.

N65-34699*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
PERFORMANCE CORRELATION FOR ELECTRON-BOMBARDMENT ION SOURCES
Harold R. Kaufman Washington, NASA, Oct. 1965 34 p refs
(NASA-TN-D-3041) CFSTI: HC $2.00/MF $0.50 CSCL 21C

A procedure is presented for estimating the gross performance characteristics of a low density electron bombardment ion source. The overall ion source performance was evaluated on the basis of the minimum discharge energy per ion, and the propellant utilization at a discharge energy twice this minimum value. Generalizing parameters were derived for these measures of performance by analysis of the more important ion source processes. These parameters involve only overall ion source measurements and available propellant properties. Within certain limits, the use of these parameters correlates the experimental data within about ±50% for minimum discharge energy and within about ±20% for the nominal propellant utilization. Two of these limits are that the discharge potential difference should not be less than 2.0 times the first ionization potential of the propellant, and that the cyclotron radius of the primary electrons emitted from the cathode should be more than 0.45 times the ionization chamber radius. This correlation is not a substitute for good design. Careful handling of design details is still necessary if the best possible performance is to be obtained. R.N.A.

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N65-33574 Michigan Univ., Ann Arbor.
INFRARED AND VISIBLE RADIATION MEASUREMENTS ON HIGH ALTITUDE BALLOON FLIGHTS AT 34-KM ALTITUDE

F. L. Bartman, L. W. Chaney, P. A. Titus, and M. G. Whybra *In its* Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 377–392 refs (See N65-33550 22-13)

The solar radiation "reflected" from clouds, and the thermal radiation emitted by the earth, clouds, and the atmosphere have been measured by four instruments on two balloon flights at 33- to 25-km altitude. The instruments used were the TIROS 5-channel, radiometer, the MRIR medium resolution radiometer, an infrared interferometer, and a grating spectrophotometer. In-flight radiation calibrations were made. Some of the results obtained by the instruments are compared, one with the other, and with theory where possible. Window channel measurements are compared with ground temperatures. Author

N65-33620# AVCO Corp., Wilmington, Mass. Research and Advanced Development Div.
MEASURING IONIC MOBILITIES IN THE MESOSPHERE Quarterly Progress Report, 1 Nov. 1964–31 Jan. 1965
H. Dolezalek 4 Feb. 1965 34 p
(Contract DA-19-020-AMC-0058(X))
(QPR-7; AD-463032)

A wind tunnel, supply circuit, signal amplification, and modified Gerdien chamber are discussed relative to measuring ionic mobilities in the mesosphere. The development and difficulties encountered in the development of a low pressure subsonic and supersonic wind tunnel having a continuous supply of fresh testing gas are discussed. The supply circuit, which is a combination of all electric components which serve to provide the desired wind velocities and pressures for the wind tunnel and the potentials for the rings and electrodes of the modified Gerdien chamber during the laboratory experiments, is considered. A summary and description of the amplification of the signal from the receiving electrodes of the modified Gerdien chamber are included. The modified Gerdien chamber is considered and includes a summary of different types of chambers, the operation of an ion gate, procedures for measuring the mobility spectrum in the laboratory, and the cancellation of main displacement current. C.T.C.

N65-33702*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
THE GAMMA-RAY SPECTRUM OF THE SUN
Joseph F. Dolan and G. G. Fazio (Smithsonian Astrophys. Obs.) [1964] 57 p refs Submitted for Publication Prepared in Cooperation with Harvard Coll. Obs.
(NASA-TM-X-51835) CFSTI: HC $3.00/MF $0.50 CSCL 20H

We investigate mechanisms for the production of gamma radiation ($h\nu > 10$ kev) by the sun and predict fluxes at the earth. The most important emission mechanism in the 10 kev to 1 Mev energy region is bremsstrahlung by flare-accelerated electrons. Flare-accelerated protons will interact with carbon, nitrogen, and oxygen nuclei by inelastic scattering and spallation reactions, producing gamma radiation as a result of nuclear de-excitation. Neutrons resulting from spallation reactions will be partially captured by protons to produce deuterium and 2.23 Mev gamma radiation. Line emission at 0.51 Mev results from positron–electron annihilation. The primary source of photons with energy greater than 50 Mev is the decay of π^0 mesons, which are also produced in proton-proton reactions. Author

N65-33720*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LOW INTENSITY DECAMETER EMISSIONS FROM JUPITER
J. K. Alexander and R. G. Stone Jun. 1964 18 p refs Presented at the 116th Am. Astron. Soc. Meeting, Flagstaff, Ariz., 24–27 Jun. 1964
(NASA-TM-X-51849; X-615-64-149) CFSTI: HC $1.00/MF $0.50 CSCL 20H

Observations of Jupiter with the 26.3 Mc/s Christiansen-type array of the Clark Lake radio observatory have been analyzed with a view towards the determination of how the noise storm morphology might be altered when very weak activity (flux $< 10^{-23}$ w/m^2/cps) is included. Analysis of the distribution of activity with system III central meridian longitude shows the same general shape as reported by other workers. Although the occurrence-probability histogram peaks are somewhat broadened in comparison to other less sensitive surveys in this frequency range, the region from 330° to 45° longitude still appears completely void of activity. Analysis of the intensity distribution at 26.3 Mc/s suggests two components of the emission. One component is comprised of a large amount of weak activity of flux density between 10^{-23} and 10^{-22} w/m^2/cps. The other, secondary component is comprised of strong activity of flux density greater than 7×10^{-22} w/m^2/cps and may correspond to the radiation commonly observed by workers at lower frequencies. Author

N65-33800*# National Aeronautics and Space Administration, Washington, D. C.
RADIATION PROCESSES IN STRATUS CLOUDS
Ye. M. Feygel'son May 1965 220 p refs Transl. into ENGLISH from the book, "Radiatsionnye Protsessy v Sloistoobraznykh Oblakakh" Moscow, Izd. Nauka, 1964 p 1–59, 66–68, 121–229
(NASA-TT-F-9331) CFSTI: HC $6.00/MF $1.25 CSCL 04B

The propagation of radiant energy in stratus clouds and the role of this energy in cloud formation and development are discussed and calculated. The problem of scattering and absorption in clouds is investigated from the viewpoint of radiation transfer. Absorption spectra of water droplets and ice crystals are given and experiments on light scattering in clouds are discussed. The role of radiant energy in the physical processes connected with cloud formation and the influence of the re-radiation from clouds to the surrounding atmosphere are discussed and programmed on an electronic computer ("Ural-1"). The problems are formulated with and without allowance for radiation. The results are compared with the calculations by other authors and with actual experiments. Numerous graphs, tabulations, and references are included. Author

N65-33813*# Consultants and Designers, Inc., Arlington, Va.
MEASUREMENTS OF LOW ENERGY PROTONS ON THE SATELLITE "COSMOS-41" [IZMERENIYA NIZKOENERGICHNYKH PROTONOV NA SPUTNIKE "KOSMOS-41"]
S. N. Vernov, I. A. Savenko, M. V. Tel'tsov, and P. I. Shavrin 31 May 1965 13 p refs Transl. into ENGLISH from a Russian Publication Presented at COSPAR 5th Space Sci. Symp., Buenos Aires, May 1965
(Contract NAS5-3760)
(NASA-TT-F-9684) CFSTI: HC $1.00/MF $0.50 CSCL 20H

Data processing results are presented on measurements of low energy protons and electrons of the outer radiation belt made by semiconductor P-r counters on the Cosmos 41 satellite. It was found that the outer radiation belt constitutes a relatively steady formation and its outer part is the only one undergoing temporal variations, beginning with $L \geq 4.5$. The identical altitude course and character of variations of low energy protons and hard electrons of the outer belt in $L \geq 5$ points to a common trapping and acceleration mechanism for both forms of radiation. Considering the dependence of these variations on the geomagnetic setup, it may be assumed

that anomalous diffusion constitutes such a mechanism for particles in the Earth's magnetosphere at the expense of relatively nonstationary disturbances of the geomagnetic field, which are observed rather frequently. R.N.A.

N65-33821*# Consultants and Designers, Inc., Arlington, Va.
RADIATION BELTS AND COSMIC RAYS [RADIATSIONNYYE POYASA I KOSMICHESKIYE LUCHI]
G. B. Zhdanov 24 Aug. 1965 7 p Transl. into ENGLISH from Vestn. Akad. Nauk. SSSR (Moscow), no. 6, 1965 p 103–105
(Contract NAS5-3760)
(NASA-TT-F-9695; ST-PF-CR-10773) CFSTI: HC $1.00/MF $0.50 CSCL 20H

This report describes the various topics of discussion during the joint session of the branches of general and applied physics, nuclear physics and Earth's sciences especially devoted to Earth's radiation belts and to the physics of cosmic rays. Author

N65-33843*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THERMAL ESCAPE OF NEUTRAL HYDROGEN AND ITS DISTRIBUTION IN THE EARTH'S THERMOSPHERE
Mordehai Liwshitz and S. F. Singer (Miami Univ.) Washington, NASA, Sep. 1965 29 p refs Prepared jointly with Miami Univ.
(NASA-TN-D-2992) CFSTI: HC $2.00/MF $0.50 CSCL 20H

A simplified model is proposed which assumes an extended transition region between the collision dominated lower thermosphere and the effectively collisionless exosphere. In this region collisions with the predominant constituent, oxygen, are still too frequent to be neglected, while the effect of thermal escape is strong enough to impede the approach to local thermal equilibrium. The behavior of hydrogen in the transition region is investigated for different oxygen temperatures by means of the Monte Carlo method. Results show that stationary conditions are attained in relatively short times which vary from about one hour at 1500° K to about one-half hour at 2500° K. The velocity distribution of hydrogen is seriously perturbed, and shows marked anisotropy as a result of escape; consequently, the loss rate of neutral hydrogen from the terrestrial atmosphere may be reduced by a factor of three or more in the range of temperatures considered. Author

N65-33846*# Consultants and Designers, Inc., Arlington, Va.
ON AN INSTABILITY LINKED WITH THE APPEARANCE OF THE EQUATORIAL SPORADIC E-LAYER [SUR UNE INSTABILITE LIEE A L'APPARITION DE LA COUCHE E SPORADIQUE EQUATORIALE]
Owen Storey and Philippe Waldteufel 27 Sep. 1965 6 p refs Transl. into ENGLISH from Compt. Rend. Acad. Sci. Ionosphere (Paris), v. 260, 9 Jun. 1965 p 6165–6168
(Contract NAS5-3760)
(NASA-TT-F-9903; STL-AI-10391) CFSTI: HC $1.00/MF $0.50 CSCL 20H

Presented are results of a theoretical analysis of the properties of a plasma instability that are presumed to be linked with the origin of the equatorial sporadic E-layer of the ionosphere. Considered is a plasma consisting of electrons and unique positive ions. An attempt is made to provide basic data for deriving analytical expressions for studying plasma instability, and to provide the basis for the satisfactory physical interpretation of stability. S.C.W.

N65-33847*# Consultants and Designers, Inc., Arlington, Va.
INVESTIGATION OF SOLAR PLASMA FLUXES ON THE INTERPLANETARY STATION "ZOND-2" [ISSLEDOVANIYA POTOKOV SOLNECHNOY PLAZMY NA MEZHPLANETNOY STANTSII ZOND-2]
V. V. Bezrukikh, K. I. Gringauz, L. S. Musatov, R. E. Rybchinskiy, and M. Z. Khokhlov Greenbelt, Md., NASA, Goddard Space Flight Center, 28 Sep. 1965 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Geofizika, (Moscow), v. 163, no. 4, 1965 p 873–876
(Contract NAS5-3760)
(NASA-TT-F-9904; ST-PF-GM-10393) CFSTI: HC $1.00/MF $0.50 CSCL 03B

This paper presents the results of measurements of a series of solar wind spectra obtained in the course of sessions having taken place during the first half of December 1964. These results are compared with previous Soviet experiments on Venus-1, Mars-1, etc., and also with the American measurements on Mariner-2. As regards the relationship between the values of solar plasma fluxes and the geomagnetic disturbance different results were obtained here when compared to those of Mariner-2. The data expounded are evidence of the necessity to pursue further the study of correlational dependences between the characteristics of geomagnetic disturbances and those of solar plasma fluxes. Author

N65-33859*# Massachusetts Inst. of Tech., Cambridge. Dept. of Physics.
COSMIC GAMMA RAYS—EXPERIMENTAL
W. L. Kraushaar [1964] 9 p refs
(Grant NsG-386; Contract AT(30-1)-2098)
(NASA-CR-64910; MIT-2098-77) CFSTI: HC $1.00/MF $0.50 CSCL 20H

As yet no experiment, satellite-borne, balloon-borne, or earth based has provided compelling evidence for more than upper limits to the intensity of cosmic gamma rays of more than a few Mev energy. Even these upper limits have been useful in blocking in some of the large scale properties of energetic particles in interstellar and intergalactic space. Nevertheless, the smallest upper limit set on the intensity of diffuse gamma rays, 3×10^{-4} cm^{-2} sec^{-1} sterad^{-1} (from the satellite experiment in Explorer XI), is a factor of about 20 above the intensity prediction which can be made with rather good confidence for gamma rays made in cosmic ray collisions with interstellar atomic hydrogen. Author

N65-33863*# Geophysics Corp. of America, Bedford, Mass.
MEASUREMENT OF UPPER ATMOSPHERIC IONIZATION AND WINDS WITH A COMBINED PAYLOAD First Quarterly Report, 24 Jul.–31 Oct. 1964
L. G. Smith and J. F. Bedinger [1964] 17 p refs
(Contract NASw-1083)
(NASA-CR-67008) CFSTI: HC $1.00/MF $0.50 CSCL 20H

Nike Apache rocket payloads were constructed which consist of a Langmuir probe for measurement of upper atmosphere atmospheric ionization and a dispenser to furnish a trail from which winds may be determined. Separate payloads with sodium vaporizer and trimethylaluminum dispensers were built. Both of the payloads were successfully launched, and measurements of electron densities and winds were obtained. J.M.D.

N65-34078 Library of Congress, Washington, D. C. Aerospace Technology Div.
NEW DATA ON THE 11-YEAR SOLAR ACTIVITY CYCLE
Edward Gelins *In its* Foreign Sci. Bull., V. 1, No. 9 Sep. 1965 p 42–50 refs (See N65-34075 22-34)

A detailed investigation of the intensity variations of the coronal 5303-Å line during the period 1954-1964 was carried out in narrow latitudinal belts of the solar surface, and it was shown that the 11-year cycle consists of two maxima which have different properties. It is claimed that all 11-year cycles observed since 1877 have two similar maxima and that the ratio of the magnitude of these maxima and the time interval between them determine the form, the duration, and the magnitude of the cycle. The correlation between the position of the active solar regions and geomagnetic perturbations was investigated; preliminary indications are that the presence of recurrent geomagnetic disturbances is connected with the passage of active regions across the visible center of the solar disk, or near it. There is speculation on a possible connection between the existence of intense and comparatively continuous processes of a nonthermal outflow of gas from the sun and peculiarities of the geomagnetic sequence. Author

N65-34306# Brookhaven National Lab., Upton, N. Y.
SOLAR NEUTRINO DETECTION BY THE Cu^{37}–Ar^{37} METHOD
Raymond Davis, Jr. and Don S. Harmer (Georgia Inst. of Tech.) 20 Jan. 1965 12 p refs
(Contract AT(30-2)-GEN-16)
(BNL-9119; CONF-650111-4)

A neutrino detection method was developed that was based upon the reaction $\nu + Cl^{37} \rightarrow Ar^{37} + e^-$. This reaction is the inverse of the electron capture radioactive decay of Ar^{37} (35 day half-life). A large volume of chlorine in the form carbon tetrachloride, CCl_4, or perchloroethylene, C_2Cl_4, was exposed and counted. Experiments were performed in an antineutrino flux reactor to test the principle of lepton conservation. It was shown that this technique could be used to observe solar neutrinos. These experiments were subjected to a large background effect from radiation. By moving the apparatus to a deep mine this cosmic ray background was essentially eliminated, and a sensitive search for solar neutrinos was made. For the purpose of setting an upper limit to the neutrino capture rate in a tank, all the events within the half-width of the Ar^{37} peak position were taken. By using the efficiency of the counter and decay corrections, an upper limit was set of 0.3 neutrino captures per day in the 3800 liters (6.1 tons) of perchloroethylene. R.W.H.

N65-34401*# Bell Telephone Labs., New York.
EXPERIMENTS ON EXPLORER XV, PROJECT SERB, STUDY ON THE ENHANCED RADIATION BELTS Final Report
30 Jun. 1964 159 p refs
(Contract NAS5-3058)
(NASA-CR-67106) CFSTI: HC $5.00/MF $1.00 CSCL 20H

The energetic particles in the trapped radiation belts were studied, with particular emphasis on the electrons artificially introduced by high altitude nuclear explosions. Radiation damage to solar cells caused by particle exposure of Explorer XV in its orbit was also investigated. The fabrication, testing, and calibration of instrumentation for particle measurements, and the design, fabrication, and testing of solar cell damage detectors are described. Circuit schematics, assembly drawings, cross sections, module layouts, and photographs amplify the text. Data reduction and analyses results are plotted for several time intervals and satellite passes, and for the radiation damage rates observed in the experiment. M.G.J.

N65-34575*# National Aeronautics and Space Administration, Washington, D. C.
SECOND SYMPOSIUM ON PROTECTION AGAINST RADIATIONS IN SPACE
Arthur Reetz, Jr. ed. 1965 519 p refs Symp. held at Gatlinburg, Tenn., 12–14 Oct. 1964
(NASA-SP-71) GPO: $3.25; CFSTI: MF $2.50 CSCL 20H

Symposium papers on radiation environment in space, biological effects of space radiation, the effects of space radiation on materials and shielding against space radiation are presented. For individual titles see N65-34576–N65-34634.

N65-34576* Rice Univ., Houston, Tex.
THE GEOMAGNETICALLY TRAPPED RADIATION
J. W. Freeman, Jr. *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 7–17 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Distribution of trapped protons and electrons in Van Allen radiation are considered in terms of a B-L coordinate system. The first adiabatic invariant of the motion of a trapped particle in a geomagnetic field is the magnetic moment of the particle, which is treated as a current loop spiraling about a field line; the trapped particle will always mirror the same value of magnetic field strength. The second adiabatic invariant defines the magnetic shell on which the particle stays as it drifts about the earth in longitude; the value given to the shell is nearly constant along a line of force. Following a magnetic storm, a redistribution and/or reduction in trapped protons was found. Flux decreases were greater for greater L values; and the protons whose mirror points were farthest from the equator suffered the greatest reduction. Relatively high intensities of naturally occurring low-to-moderate energy electrons are found throughout the entire region of durable trapping within the magnetosphere, and only naturally occurring electrons are found in the outer radiation zone. M.W.R.

N65-34577* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
REVIEW OF GALACTIC AND SOLAR COSMIC RAYS
F. B. Mc Donald *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 19–29 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

The multiply charged particles observed in the primary cosmic ray beam furnish a direct sample of galactic material from which measurements of chemical composition of galactic cosmic rays and abundance of various elements can be made. Measurements indicate an overabundance of elements in the range greater than carbon and the presence of lithium, beryllium, and boron. Another distinguishing feature of the galactic radiation is its energy spectrum which extends from 10^7 to 10^{19} electron volts. Primary cosmic radiation is essentially isotropic over the celestial sphere. Spectral and propagation characteristics of the solar cosmic rays are discussed in light of occasions between 1956 and 1963 when solar production had a minimum integrated intensity of 10^8 particles/cm^2 at energies > 30 MeV observed at the earth. It is shown that particles of all energies travel a given path length with equal probabilities; since most particles travel a distance of an order larger than one astronomical unit, propagation must involve an important degree of scattering. M.W.R.

N65-34578* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE MAGNETOSPHERE AND ITS BOUNDARY LAYER
Norman F. Ness *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 31–40 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Studies of cosmic rays, magnetic fields, and solar winds in the magnetosphere and boundary layer made during the flight of IMP-I (Interplanetary Monitoring Platform) are summarized. Projections of the first four orbits of the IMP-I

satellite are illustrated, and characteristics of the experiments performed by the satellite are tabulated. Magnetic field measurements of the magnetosphere made by the first inbound orbit of IMP-I are given; and the theoretical size of the magnetosphere at the subsolar point, assuming normal impact of the solar plasma on the geomagnetic field, is graphed. At very large distances from the earth, plasma flow is principally from the sun; but at a distance of 13.6 R_e, the flow suddenly comes from all directions and the magnetic field increases appreciably. Preliminary observations indicate that the termination of the turbulent transition observed as the satellite moves radially away from the earth may be interpreted to be the collisionless magnetohydrodynamic shock wave associated with the interaction of the solar wind and geomagnetic field. M.W.R.

N65-34579* National Aeronautics and Space Administration, Washington, D. C.

SOLAR PERTURBATIONS OF THE SPACE ENVIRONMENT

Henry J. Smith *In its* 2d Symp. on Protec. against Radiations in Space 1965 p 41–46 (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

The solar constant and expansion of the corona are discussed in terms of the sun's influence upon the earth's space environment. While measurements of short term variations of the solar constant during the solar cycle are relatively few, long term changes of large magnitude have been made to explain paleoclimatic changes. Average error of measurement in this instance is 0.0023 stellar magnitudes, whereas stellar astronomers have found errors ten times larger among field stars. It is concluded that the sun is more constant than any known star. Comet tails, which are considered to serve as space probes, are subject to some force 50 times greater than solar gravitation. It is conjectured that this force is momentum of the solar wind transferred to the cometary plasma by magnetic coupling. While some solar perturbations can be explained by quantitative association of optical solar events, the M-regions and many phenomena require further explanations. Mention is made of spacecraft observations which have provided new data on solar extreme ultraviolet radiation. Solar influence on the upper atmosphere is considered. M.W.R.

N65-34580* Aerospace Corp., El Segundo, Calif.

THE UPDATING AND DISSEMINATION OF THE KNOWLEDGE OF TRAPPED RADIATION—MODEL ENVIRONMENTS

James I. Vette *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 47–55 (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

(NASA Order W-11683)

A program is described for producing, updating, analyzing, and displaying model environments of trapped radiation. Data received from various experimental groups are compared to determine flux distribution, energy spectrum, and absolute value of flux. A model environment was determined for electron energies above 300 keV, and the distribution function for electrons above 0.5 MeV is shown in a B–L flux map. This model environment is then compared with input data at L=1.5; a typical spread in the data for the various L values is obtained. Differential energy spectra of the model environment are illustrated; and integrated electron fluxes for 30° and 90°, inclination orbits are compared for the model environment and E8 grids obtained earlier. These model environment data will be available on IBM punched card decks, B–L flux maps, and orbital integration tables for the specific purposes of satellite engineering and system planning. M.W.R.

N65-34606* Air Force Systems Command, Kirtland AFB, N. Mex.

RADIATION SPECTROMETRY IN SPACE: REQUIREMENTS FOR ACCURATE DOSE DETERMINATIONS

Benton C. Clark *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 235–244 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

An analysis was performed to find relationships between dose calculation errors and radiation measurement errors; the assumption was made that the dose calculation itself is without error in order to isolate the requirements on the basic data itself. It was found, in general, that errors in critical experiment parameters are magnified considerably because of the functional form of the dependence of dose on energy spectrum, and on parameters such as count rate and energy threshold. Other sources of error involve angular resolution, spatial resolution, and temporal resolution. It was concluded that there are several sources of error in particle measurements, and that a good spectrometer must cover a large range in both energy and particle flux level. It was also suggested that this can probably be accomplished accurately only by a large, sophisticated instrument weighing perhaps 15 to 30 pounds. M.G.J.

N65-34608* Martin Co., Baltimore, Md.

PROTON FLUX, DOSAGE, AND DAMAGE ESTIMATES IN THE VAN ALLEN BELT

S. Russak and K. Richardson *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 251–256 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Proton fluxes and spectrums have been obtained for a number of near earth circular and elliptical orbits. From these, radiation dose versus absorber thickness and solar cell damage estimates have been made. The environmental model to obtain flux uses McIlwain's empirical data from Explorer XV. The distribution of protons with energy as used in the calculation varies with position in the geomagnetic field in accordance with the relationship derived by Imhof and Smith. These have been combined into a single IBM 7094 program which determines flux and composite incident spectrum at various points along the orbit and calculates emergent spectrum and dose within simple or complex configurations. The results obtained are compared with earlier dosage estimates based upon the Freden and White spectrum and a flux model derived from Explorer IV data. Author

N65-34622* Republic Aviation Corp., Farmingdale, N. Y.

SOLAR FLARE HAZARD TO EARTH-ORBITING VEHICLES

E. Kuhn, F. E. Schwamb, and W. T. Paine *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 429–434 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

(Contract NAS1-3601)

Procedures are developed for calculating approach cones for solar flare particles at points on the orbit of an earth satellite, taking into account the effects of the geomagnetic field and also the magnetic effects of the solar flare. The purpose is to provide information for optimum shielding design for satellites. Three models are considered for the geomagnetic field: (1) a pure dipole field, treated by simple Störmer theory; (2) a dipole field with a superposed time-dependent uniform field to simulate the effects of the magnetic storm, treated by a modified Stormer theory; and (3) same as model (2) but with shadowing effects of the earth considered in an approximate way. Computer programs have thus far been constructed for the first two of these models. Author

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N65-33551 National Aeronautics and Space Administration, Washington, D. C.
THE APPLICATIONS OF REMOTE SENSORS IN PLANETARY EXPLORATION
Peter C. Badgley *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 9–28 (See N65-33550 22-13)

In the planning of scientific payloads for future earth and planetary (Mars, Venus) orbital spacecraft, sensors which are being considered include detectors to measure infrared, microwave, X-ray and gamma ray emittance, active radar systems, multiband photography, and gravity and magnetic sensors. The current feasibility program and its relationship to future manned missioni are discussed. Author

N65-33552 Bendix Corp., Ann Arbor, Mich. Systems Div.
APPLICATION OF A PHOTOMETRIC TECHNIQUE FOR MAPPING THE LUNAR SURFACE
M. E. Amdursky *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 29–49 refs (See N65-33550 22-13)

The studies discussed in this paper have been performed to gain knowledge on how the lunar landscape might appear to an image-forming device such as a television camera and display system and how the unique back-scattering lunar photometric function may be utilized to aid in determining the existence and nature of slopes and other lunar features. A simulated lunar model which exhibits the photometric characteristics and an analysis of the accuracies achievable will be described. Means by which a computer can be used to analyze the video data are suggested. The limitations of the technique and its relative value in comparison to other map-making methods such as photogrammetry are also discussed. Author

N65-33553 AVCO Corp., Cincinnati, Ohio.
RADAR MAPPING OF VENUS FROM AN ORBITING SPACECRAFT
R. F. Schmidt *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 51–81 (See N65-33550 22-13)

The results of a preliminary design study show that a radar operating from a Venus orbiter can be used to map the planet surface. Objectives are to provide a high resolution map of the planet topography and reflectivity, and to determine other characteristics of the surface. The rotational period of the planet could also be deduced. The mapping radar will provide surface resolutions of approximately 20 kilometers or better depending on orbit altitude. The location of prominent surface features may be fixed to within several kilometers if the antenna scan is restricted during measurements. Accurate relief or surface contour mapping can be accomplished over a restricted angular region directly below the spacecraft because the effects of planet curvature and non-vertical incidence introduce errors in altitude measurements. The relationships between orbit characteristics, surface characteristics, and data resolution, and the constraints they impose on system design are indicated. Author

N65-33556 National Aeronautics and Space Administration, Washington, D. C.
THE ROLE OF REMOTE SENSING IN THE NASA MANNED INTERPLANETARY PROGRAM AND VICE VERSA
Rollin W. Gillespie *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 79–90 refs (See N65-33550 22-13)

The remote sensing of planetary and interplanetary environments is essential to planning and establishing manned interplanetary capability, while that capability will extend the opportunities for remote sensing. Some engineering features of any possible manned interplanetary program are given as a guide in planning remote sensing experiments. It is urged that terrestrial and planetary applications of remote sensing should be integrated, at once. Author

N65-33604*# Virginia Polytechnic Inst., Blacksburg.
THE ROLE OF SIMULATION IN SPACE TECHNOLOGY, PART B
[1964] 258 p refs Proc. of Conf. held on 17–21 Aug. 1964 *Its* Eng. Extension Ser. Circ. No. 4
(Contract NASr-226)
(NASA-CR-64950) CFSTI: HC $6.00/MF $1.50 CSCL 22A

CONTENTS:

1. HYPERSONIC FLIGHT SIMULATION: AERODYNAMICS J. L. Potter (ARO, Inc.) 60 p refs (See N65-33605 22-01)

2. CONVECTIVE AND RADIATIVE HEAT TRANSFER DURING REENTRY AND ADVANCED TECHNIQUES FOR THEIR SIMULATION T. N. Canning 27 p refs (See N65-33606 22-33)

3. EVALUATION OF MATERIALS IN ENTRY HEATING SIMULATION W. A. Brooks, Jr. (Langley Res. Center) 44 p refs (See N65-33607 22-33)

4. DETECTION OF, AND COMMUNICATION WITH SPACE VEHICLES DURING ATMOSPHERIC ENTRY; PROBLEMS IN SIMULATION S. C. Lin (AVCO-Everett Res. Lab.) 29 p refs (See N65-33608 22-07)

5. FLIGHT REENTRY EXPERIMENTS H. A. Wilson, Jr. and R. L. Wright (Langley Res. Center) 26 p (See N65-33609 22-31)

6. BACKGROUND OF PILOTED SIMULATOR DEVELOPMENT C. B. Westbrook (AFSC, Wright-Patterson AFB) 69 p refs (See N65-33610 22-11)

N65-33611*# Virginia Polytechnic Inst., Blacksburg.
THE ROLE OF SIMULATION IN SPACE TECHNOLOGY, PART C
[1964] 270 p refs Proc. of a Conf. held on 17–21 Aug. 1964 *Its* Eng. Extension Ser. Circ. No. 4, Pt. C
(Contract NASr-226)
(NASA-CR-64951) CFSTI: HC $6.00/MF $1.50 CSCL 22B

CONTENTS:

1. COMPUTERS FOR SIMULATION OF SPACE VEHICLE SYSTEMS R. M. Howe (Mich. Univ.) 21 p refs (See N65-33612 22-31)

2. DISCUSSION OF EXISTING AND PLANNED SIMULATORS FOR SPACE RESEARCH A. W. Vogeley (Langley Res. Center) 40 p (See N65-33613 22-30)

3. VISUAL AND MOTION SIMULATION TECHNIQUES J. L. Brown (Penna. Univ.) 34 p refs (See N65-33614 22-30)

4. DYNAMIC SIMULATORS FOR TEST OF SPACE VEHICLE ATTITUDE CONTROL SYSTEMS G. A. Smith (Langley Res. Center) 30 p refs (See N65-33615 22-31)

5. INTRODUCTION TO THE SESSION ON STRUCTURAL DYNAMICS I. E. Garrick (NASA) 2 p (See N65-33616 22-32)

6. PRINCIPLES AND PRACTICES FOR SIMULATION OF STRUCTURAL DYNAMICS OF SPACE VEHICLES G. W. Brooks (Langley Res. Center) 46 p refs (See N65-33617 22-32)

7. MODELS FOR OBTAINING EFFECTS OF GROUND WINDS ON SPACE VEHICLES ERECTED ON THE LAUNCH PAD W. H. Reed, III (Langley Res. Center) 56 p refs (See N65-33618 22-20)

8. SIMULATION OF STRUCTURAL DYNAMICS OF SPACE VEHICLES DURING LAUNCH H. L. Runyan (Langley Res. Center) 40 p refs (See N65-33619 22-32)

N65-33622# Iowa State Univ. of Science and Technology, Ames. Dept. of Mechanics and Hydraulics.

DATA ACQUISITION AND REDUCTION. PHASE V, PART I: VARIATIONS OF THE TRAJECTORY OF AN UNGUIDED ROCKET CAUSED BY STATISTICAL VARIATIONS IN PARAMETERS

W. John Denkmann and Royce E. Beckett 15 Nov. 1963 45 p (Contract DA-11-070-508-ORD-1232)
(Rept.-9; AD-460978)

This report presents the results of numerical computations made to determine the dispersion from a nominal trajectory of an unguided artillery rocket. Factors which cause dispersion are variables whose magnitudes cannot be prescribed and which will occur according to some statistical pattern. Examples are motor malalignment and wind gusts. The effect on dispersion of a given variable is dependent upon the conditions at tip-off from the launcher. The tip-off conditions are in turn subject to control by the design of the launcher. Control of the dispersion of a rocket is related graphically to the design parameters of a launcher. Author

N65-33627* National Aeronautics and Space Administration, Washington, D. C.

REMARKS ON SIMULATION IN AERONAUTICAL AND SPACE TECHNOLOGY

Raymond L. Bisplinghoff *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. D [1964] 9 p (See N65-33625 22-32) CFSTI: HC $6.00/MF $1.25

The necessity of developing better and more efficient space simulation techniques and facilities is discussed. Current simulation processes are not sufficient to evaluate the many problems of a lightweight nuclear-electric power system that is required for future spacecraft on-board power and electric propulsion; to simulate the environment of an airbreathing propulsion system for Mach 6 flights and beyond; or to simulate the space environment including the vacuum, the full energy levels of elementary and finite particles, and the electromagnetic radiation. A zero gravity environment also poses difficult simulation problems for the behavior of liquid and vapor systems, as well as sustained observations on life environments. G.G.

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N65-33666# Naval Research Lab., Washington, D. C.

REPORT OF NRL PROGRESS

Jun. 1965 63 p refs
(PB167681) CFSTI: $1.25

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2. DECAMETER-WAVE RADAR STUDIES OF THE LUNAR SURFACE J. R. Davis, D. C. Rohlfs, G. A. Skeggs, and J. W. Joss (RCA Serv. Co., Inc.) p 7–16 refs (See N65-33667 22-30)

PROBLEM NOTES

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5. MECHANICS p 22–25 refs

6. METALLURGY AND CERAMICS p 26–39 refs

7. OPTICS p 40 ref

8. RADIO p 40–47 refs

9. SOLID STATE PHYSICS p 47–51 refs

SUPPORTING TECHNIQUES

10. A LOGARITHMIC AMPLIFIER WITH 60-db RANGE G. L. Harvey p 52–56

11. AN APPARATUS FOR SIMULTANEOUSLY MEASURING MULTIPLE THRESHOLD POTENTIALS WITH A TIME-OF-FLIGHT MASS SPECTROMETER R. S. Olfky and F. E. Saalfeld p 56–58 refs

12. A GRAPH WHICH DETERMINES THE NUMBER OF CROSSOVERS IN UNIVERSAL WOUND COILS M. S. Lieberman p 58–60 refs

N65-33667 Naval Research Lab., Washington, D. C.

DECAMETER-WAVE RADAR STUDIES OF THE LUNAR SURFACE

J. R. Davis, D. C. Rohlfs, G. A. Skaggs, and J. W. Joss (RCA Serv. Co., Inc., Camden, N. J.) *In its* Rept. of NRL Progr. Jun. 1965 p 7–16 refs (See N65-33666 22-30) CFSTI: $1.25

An extended series of decameter-wave measurements of the total radar cross section of the moon has corroborated a previous NRL suggestion that this parameter has a substantially larger value in the decameter region than at shorter wavelengths. Examples are given of the ionospheric effects which require decameter-wave measurements conducted over a transionospheric path to be regarded with caution. A beginning study of possible discrete scattering centers located in regions toward the limb of the moon is described. Author

N65-33675# Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center.

LUNAR THERMOPHYSICS Annotated Report Bibliography

Charlotte F. Shenk, Herbert P. Eckstein, and William P. Mc Nutt Jun. 1965 282 p
(RSIC-419; AD-469037)

This bibliography, most of which is annotated, contains 673 citations, and is conveniently arranged under 30 sections related to thermal physics of the moon. These sections are Albedo; Atmosphere-Ionosphere; Bibliographies; Books; Color; Composition; Craters, Maria and Rays; Dust; Earth Shine; Eclipse; Environment; Exploration; General Information; Infrared; Instrumentation and Equipment; Light-Optical Properties; Luminescence; Photometry; Polarimetry and Polarization; Radar and Radio Echo; Radiation, Ultraviolet and Nuclear; Radio Emission-Radio Astronomy; Radiometry; Selenology; Spectrophotometry; Spectroscopy-Spectrometry; Sputtering, Solar Wind; Tektites; Temperature; and Topography. The Radar and Radio Echo Section has 96 citations, and the Photometry, Selenology, Radio Emission-Radio Astronomy, and Temperature Sections have over 40 citations each. Author

N65-33719*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

SEQUENCE OF EVENTS IN THE EARLY PHASE OF THE SOLAR SYSTEM

Su-Shu Huang [1964] 12 p refs Submitted for Publication (NASA-TM-X-51850) CFSTI: HC $1.00/MF $0.50 CSCL 03B

The construction of a sequence of events in the early phase of the solar system by uniting several recent theories in various fields of learning is presented. Some investigations

showed that there were strong magnetic activities on the surface of the primeval sun. The light elements, lithium, beryllium, and boron, were produced by spallation processes when high energy particles bombarded the dense material in the solar nebula. It was also shown that the premain sequence stars must be in a convective equilibrium. Evolutionary tracks were calculated in the H-R diagram for these stars of several masses including the solar mass. It was concluded that events in the early phase of the solar system formed a natural sequence, and therefore the existence of planetary systems around main-sequence stars, especially of spectral type later than F5 where axial rotation stops, must be common in the universe.
R.W.H.

N65-33721# Royal Aircraft Establishment, Farnborough (England)
A TRANSFER MANOEUVRE BETWEEN TWO NON-COPLANAR ELLIPTIC ORBITS [MANEVR PEREKHODA MEZHDU DVUMYA NEKOPLANARNYMI ELLIPTICHESKIMI ORBITAMI]
M. M. Nita Feb. 1965 22 p refs Transl. into ENGLISH from Rev. Mecan. Appl. Acad. Rep. Populaire Roumaine (Rumania), v. 8, no. 6, 1963 p 1039–1055
(RAE-LIB-TRANS-1097) CFSTI: HC $1.00/MF $0.50

This paper describes the manoeuvre required to change the plane of an elliptic orbit while retaining the shape of the orbit, on the assumption that the thrust/mass ratio of the satellite is constant and that the direction of thrust of the engine is fixed in space. By using some results which were obtained in a previous paper, an analysis is made of the manoeuvre in which the satellite, under the action of this engine, assumes uniform circular motion in a plane which does not include the earth's centre O. Then formulae for the variation of the positional elements of the final orbit are derived and it is shown that the direction of the plane of the manoeuvre and the thrust of the engine are determined by the eccentricity of the initial orbit, two types of manoeuvre being possible for each orbit of specific eccentricity. The maximum values of the inclination of the final orbit are determined from analysis of the results obtained. Author

N65-33723*# California Univ., San Diego.
THE CONTRACTION OF MOLECULAR HYDROGEN PROTOSTARS
Robert J. Gould [1963] 19 p refs Submitted for Publication
(Grant NsG-357)
(NASA-CR-58065) CFSTI: HC $1.00/MF $0.50 CSCL 03B

It is shown that molecular hydrogen protostars larger than about a solar mass suffer a rapid free fall collapse when they are still quite cool (~50° K). The collapse results from the high luminosity of a transparent protostar for 28μ line radiation resulting from the J = 2 to J = 0 rotational quadrupole transition in parahydrogen. The possibility of detecting galactic 28μ radiation and star formation is considered. Author

N65-33735# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
SOLAR SIMULATION: REQUIREMENTS FOR LARGE AEROSPACE ENVIRONMENTAL CHAMBERS
George Mac Farlane Aug. 1965 99 p refs
(AEDC-TR-65-164; AD-469008)

This report summarizes discussions held with technical and managerial personnel of more than a dozen aerospace companies on various aspects of solar simulator design and test philosophy. Inasmuch as space vehicles fall into two main classes, each having characteristics which are manifestly different, two types of solar radiation simulators are required in large space environmental facilities. For small vehicles of the scientific class, solar radiation of high quality must be provided over a test area of limited size. For large manned vehicles designed for missions of extended duration in earth orbit, for travel to and on the moon, and for interplanetary exploration, adequate testing accuracy can be obtained by providing solar radiation of lower quality over floor areas measured in thousands of square feet. Moreover, since instrumentation difficulties preclude the exact measurement of the various radiometric quantities, the cost of a solar simulator system can be significantly reduced by taking care not to overspecify the performance required. Author

N65-33761# Colorado Univ., Boulder. Dept. of Aerospace Engineering Sciences.
THE PROBLEM OF CONTANGENTIAL TRANSFER
Nguyen X. Vinh Wright-Patterson AFB, Ohio, ARL, May 1965 179 p refs
(Contract DA-31-124-ARO(D)-139)
(ARL-65-108; AD-619028)

Solution of the optimum cotangential transfer between two coplanar, noncoaxial, elliptical orbits is presented. The characteristic velocity is expressed explicitly in term of a single parameter. By optimizing this function with respect to the variable, a resultant equation which is a high order algebraic equation is obtained. Numerical solution can be calculated to the desired degree of accuracy. Exact analytical solutions are given for all special cases of the terminal conditions. Second order approximate solution which can be applied to a large range of missions (interplanetary transfer, transfer of a satellite from a parking orbit to a high energy elliptical orbit...) is derived and gives an excellent degree of accuracy (less than 1 ft/sec for the characteristic velocity and less than 30' for the position of transfer). Author

N65-33810*# National Aeronautics and Space Administration, Washington, D. C.
REPORT ON CERTAIN ASPECTS OF SPACE ENVIRONMENT SIMULATION [EXPOSE DE SYNTHESE SUR CERTAINS ASPECTS DE LA SIMULATION DE L'ENVIRONMENT SPATIAL]
S. Choumoff Sep. 1965 42 p refs Transl. into ENGLISH from FRENCH Presented at the 7th Intern. Aeron. Congr., AFITAE, Paris, 14–16 Jun. 1965
(NASA-TT-F-9574) CFSTI: HC $2.00/MF $0.50 CSCL 22A

Various space environment simulators, including NASA, General Electric, Jet Propulsion Laboratory units, are reviewed, with brief description of their function and expected life. The Plum Brook and Mark projects are evaluated, and the simulator of the French Subsidiary of Thomson–Houston is described. A combination of vibration, temperature, and vacuum tests is suggested, for more accurate failure detection. The importance of accurate estimates of energy and heat dissipation, inside the satellite, thermal gradients, energy loss by radiation of the satellite, and other environmental parameters is stressed and demonstrated by tabulated data. Author

N65-33814*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OPTIMUM ENERGY FLIGHTS TAKING INTO ACCOUNT THE EFFECT OF LIGHT PRESSURE [ENERGETICHESKI OPTIMAL'NYYE POLETY S UCHETOM VLIYANIYA SVETOVOGO DAVLENIYA]

S. N. Kirpichnikov 14 Jun. 1965 20 p refs Transl. into ENGLISH from Vestn. Leningr. Univ., Ser. Mat., Mekh. i Astron. (Leningrad), v. 2, 1965 p 144–156
(NASA-TT-F-9686; ST-CM-10344) CFSTI: HC $1.00/MF $0.50 CSCL 22A

Consideration is given in the present work to one-impulse flights between Keplerian orbits of given boundary in the gravitational field of the Sun. All of the three orbits are coplanar. The initial mass is minimized. The pressure of sunlight is taken into account on the intermediate orbit of the flight. Analytical solutions are obtained in the special cases of circular boundary orbits and on boundaries of orbits with small eccentricities. Author

N65-33817*# Consultants and Designers, Inc., Arlington, Va.
NEW DATA ON SOLAR ACTIVITY AND ITS INFLUENCE ON THE EARTH [NOVVYE DANNYYE O SLONECHNOY AKTIVNOSTI I YEYE VLIYANIYE NA ZEMLU]
M. N. Gnyshev 2 Jul. 1965 9 p Transl. into ENGLISH from Vestn. Akad. Nauk SSSR (Moscow), no. 5, 1965 p 67–71
(Contract NAS5-3760)
(NASA-TT-F-9691; ST-SP-SB-10350) CFSTI: HC $1.00/MF $0.50 CSCL 04A

This paper reviews the new solar data provided by the Kislovodsk astronomical station of the main astronimical observatory of the USSR Academy of Sciences. The author asserts that measurements of the outer layers of the solar atmosphere were more precise at that station than at any other of the eight world stations. Several aspects of solar-terrestrial relationships are discussed, including the biophysical effects on human beings. Author

N65-33818*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
RADIOASTRONOMICAL INVESTIGATIONS AND IONOSPHERE OF VENUS [RADIOASTRONOMICHESKIYE ISSLEDOVANIYA I IONOSFERA VENERY]
A. D. Danilov 14 Jul. 1965 10 p Transl. into ENGLISH from Astron., Dokl. Akad. Nauk SSSR (USSR), v. 162, no. 4, 1965 p 774–777
(NASA-TT-F-9692; ST-RA-LPS-10356) CFSTI: HC $1.00/MF $0.50 CSCL 03B

The present work is especially devoted to the review of the new data related to the problem of origin of Venus' eigenstrahlung, or own radioemission and its connection with the planet's ionosphere. The author points to a series of indications that the results of radioastronomical investigations of Venus are apparently linked with the ionosphere, and that it should be taken into account when interpreting experimental data regardless of the model that explain the total spectrum of brightness temperatures of planet's radioemission. In spite of the fact that the present work is not especially based upon the materials, which, according to the author, point to the presence on Venus of a dense ionosphere, he still believes that they are evidence that the scheme of Venus' ionosphere is more complex than was believed so far, and requires further ascertaining. Author

N65-33819*# Consultants and Designers, Inc., Arlington, Va.
RADAR OBSERVATIONS OF VENUS IN THE SOVIET UNION IN 1964 [RADIOLOKATSIONNYYE NABLYUDENIYA VENERY V SOVETSKOM SOYUZE V 1964 G.]
V. A. Kotel'nikov, Yu. N. Aleksandrov, L. V. Apraksin, and A. M. Shakhovskoy 11 Aug. 1965 8 p refs Transl. into ENGLISH from Astron., Dokl. Akad. Nauk SSSR (USSR), v. 163, no. 1, 1965 p 50–55
(Contract NAS5-3760)
(NASA-TT-F-9693; ST-RA-LPS-10369) CFSTI: HC $1.00/MF $0.50 CSCL 03A

This paper describes the results of radar location of Venus during 1964 as the continuation of previous similar observations in 1961 and 1962. It is found that the energy of reflected signals decreases more rapidly with the increase of the incidence angle than was observed in 1962. A joint consideration of the results of determination of Venus' rotation period in 1962 and 1964 shows that the orientation of the rotation axis is nearly perpendicular relative to Venus' orbit plane. Author

N65-33835*# IIT Research Inst., Chicago, Ill.
A REVIEW OF RECENT DETERMINATIONS OF THE COMPOSITION AND SURFACE PRESSURE OF THE ATMOSPHERE OF MARS
M. W. P. Cann, W. D. Davies, J. A. Greenspan, and T. C. Owen Washington, NASA, Sep. 1965 186 p refs
(Contract NAS5-9037)
(NASA-CR-298) CFSTI: HC $5.00/MF $1.25 CSCL 03B

Recent determinations of the Martian surface pressure are reviewed. The polarimetric work of Dollfus is discussed and a new value of the surface pressure, 63 mb, is derived from his data making use of more recent photometric data and of a new treatment of the angular dependence of the planetary surface brightness. A photometric argument by Musman is discussed and the general effects of aerosols and various mixtures of gases on the pressure estimates are investigated. It is shown that these lead to a range of pressures depending on the assumptions made, and that this method of pressure determination leads to indeterminate results. Several spectroscopic works are reviewed and a value of 45 ±25 m-atm for the Martian CO_2 abundance is derived, corresponding to a mean Martian atmospheric temperature of 200° K. Using this abundance, various methods for estimating the surface pressure are reviewed, leading to surface pressures ranging from 13 to 33 mb with relative errors on the order of ±90%. The large uncertainty is due to the fact that the abundance determination rests on the measurement of three weak lines in a single spectrogram. R.N.A.

N65-33845*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
LUNAR LANDING AND SITE SELECTION STUDY
James L. Lewis and Charles D. Wheelwright Washington, NASA, Sep. 1965 22 p refs
(NASA-TN-D-2999) CFSTI: HC $1.00/MF $0.50 CSCL 22A

A study was made of the possible extension of the launch window for the Apollo mission by defining the minimum brightness level for successful lunar landing. The pilot's ability to select and commit to a landing site, the trajectory, and window visibility requirements were evaluated in various lunar brightness levels. A helicopter with a modified LEM window was used on the LEM trajectories from 1000 feet altitude to the surface. Fifty flights were made over homogeneous terrain. Observers wore neutral density filters to simulate lunar brightness levels ranging from 1/4 earthshine, lowest mare albedo, to full earthshine, maximum mare albedo. Landing site selection, commitment to landing, and total time to touchdown are generally inversely proportional to the brightness level. Observer comments indicate that the pilot's landing commitment confidence level is unacceptable below a brightness level of 0.04 footlambert. Author

N65-33848* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RANGER VII PHOTOGRAPHS OF THE MOON. PART III: CAMERA "P" SERIES
Gerard P. Kuiper Washington, NASA, Aug. 1965 235 p refs Sponsored by NASA
(NASA-SP-63) GPO: HC $6.50: CFSTI: MC $1.25 CSCL 03B

Seven hundred and fifty-eight of the more than 3900 photographs taken with the four partial-scan P cameras aboard Ranger VII are presented. The frames, each of which contains a photograph from each camera, were selected so that sampling increases as the spacecraft approaches the moon. All of the last 70 frames taken are included; the last ten frames presented are duplicates of the previous ten, with digital processing employed to reduce coherent noise and suppress the camera reticles. Characteristics of the cameras are tabulated; and detailed information is included for each of the photographs shown, including spacecraft and camera positions, E–W and N–S scales, and deviation north. M.W.R.

N65-33849*# Douglas Aircraft Co., Santa Monica, Calif. Missile and Space Systems Div.
EXPERIMENTAL INVESTIGATION OF ULTRA-HIGH VACUUM ADHESION AS RELATED TO THE LUNAR SURFACE Fourth Quarterly Progress Report and First Year Summary, 1 Apr.–30 Jun. 1965
J. A. Ryan [1965] 135 p refs
(Contract NAS7-307)
(NASA-CR-67011; SM-47914) CFSTI: HC $4.00/MF $1.00 CSCL 03B

This report presents the results obtained during the past year on the ultra-high vacuum adhesion of silicates as related to the lunar surface. Silicates, such as may exist at the lunar surface, were contacted with silicates and with engineering materials which may be used at the lunar surface. The adhesion was measured as a function of load force, temperature, and type of material. Load forces up to about 1000 grams were applied; temperature was varied from about 100° K to about 400° K, approximately the lunar temperature range. Adhesion as small as 20 μg could be detected. Materials used were orthoclase, albite, bytownite, hornblende, hypersthene, and obsidian among the silicates; aluminum, magnesium, titanium alloy, Stainless Steel, and beryllium among the metals; a ceramic (alumina) and a commercial glass. A definite load dependence for the adhesion was detected. For some samples no adhesion was detected at low loadings, but as load was increased the adhesion increased rapidly to relatively large values (generally hundreds of milligrams). All evidence indicates that this behavior is produced by the action of the normal atomic bonding forces. Author

N65-33861*# Republic Aviation Corp., Farmingdale, N. Y. Space and Missile Systems Div.
STUDY TO INVESTIGATE THE STABILITY IN ORBIT DETERMINATION Technical Summary Report, 16 Apr. 1964–15 Apr. 1965
Seymour Sherman 14 Apr. 1965 82 p refs
(Contract NAS5-3811)
(NASA-CR-64942; RAC-1740-1; SMSDAM-TR-65-4) CFSTI: HC $3.00/MF $0.75 CSCL 22C

The stability of the Kalman filter as it is applied to orbit determination, and the dependence of its behavior on the transition matrix, the initial covariance matrix, the types of observations, and the covariance of the noise in the measurements is explored using a basic simple harmonic motion model with zero and negative damping. Author

N65-33862*# Boston Univ., Mass.
THE ZONE OF SUPERSONIC FLOW CAUSED BY LARGE METEORITES STRIKING THE LUNAR SURFACE Research Report No. 15
M. P. Batra Mar. 1965 40 p refs *Its* Astron. Contrib. Ser. II, No. 40
(Grant NsG-246)
(NASA-CR-67002) CFSTI: HC $2.00/MF $0.50 CSCL 22A

We have applied the blast-wave theory, utilizing the self similarity technique, for solving the equations of the Fluid-Mechanical model. The penetration of the meteorite to the depth when its velocity becomes acoustic has been found to be equal to 4 to 6 meteorite diameters, depending upon the impact velocity and the mass of the meteorite. This confirms the prediction made by Baldwin for the penetration of the meteorite in the formation of craters with Central Mountain peak. This limit of penetration is called the 'sonic-crater depth' The sonic-crater depth also happens to be approximately equal to the depth of Central Mountain peak from the level ground. The sonic-crater depths can be scaled for different velocities, different masses and different substances using Bjork's scaling laws. The sonic depth, after having been scaled for iron and tuff, agrees fairly well with that computed by Bjork for the meteor crater Arizona. We have also confirmed the 2/3 power law of Eichelberger & Gehring and Walsh & Tillotson. Author

N65-33864*# RAND Corp., Santa Monica, Calif.
INVARIANT IMBEDDING AND PERTURBATION TECHNIQUES APPLIED TO DIFFUSE REFLECTION FROM SPHERICAL SHELLS
R. E. Bellman, H. H. Kagiwada, and R. E. Kalaba Aug. 1965 13 p refs
(Contract NASr-21)
(NASA-CR-64996; RM-4730-NASA) CFSTI: HC $1.00/MF $0.50 CSCL 03B

This memorandum presents a method for integrating numerically the invariant imbedding relation for the diffuse reflection coefficient of a spherical shell. The reflection coefficient of a shell is related to that of a slab via a perturbation technique. The results of some test calculations are presented; they compare well with results obtained in an earlier memorandum using a different method. Interestingly enough, the perturbation technique proves useful for quite large values of the perturbation parameter. Author

N65-33878*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-34, VOLUME VI FOR THE PERIOD MAY 1, 1965 TO JUNE 30, 1965. SPACE EFPLORATION PROGRAMS AND SPACE SCIENCES
31 Jul. 1965 53 p ref
(Contract NAS7-100)
(NASA-CR-64884; JPL-SPS-37-34, Vol. VI) CFSTI: HC $3.00/MF $0.50 CSCL 22A

A summary is presented of activities related to the Mariner, Ranger, and Surveyor projects; the Deep Space Instrumentation Facility; environmental test facilities; and space instruments and systems. A Ranger VIII trajectory analysis is included, and Mark II L-band communications system performance during block III missions is discussed. A likely cause of failure of the L-band system was a conductive particle, floating in the zero-g environment, that was moved to cause a short by the cessation of the roll turn and was dislodged by the motor burn. Flight operations and radio subsystem performance are considered for the Mariner IV as are ionization chamber and plasma

probe failure analyses. Spurious TV image phenomena are discussed. A preliminary study of the stability of a multiple-vibration-exciter control system is included and a special equalization procedure for random vibration testing is presented. M.W.R.

N65-33880*# Space Technology Labs., Inc., Redondo Beach, Calif.

PERTURBATIONS OF CIRCULAR SYNCHRONOUS SATELLITE ORBITS

Richard L. Dunn 5 Feb. 1962 21 p refs
(Contract NAS5-1302)
(NASA-CR-64899; STL-8616-6005-RU-000) CFSTI: HC $1.00/MF $0.50 CSCL 22C

Satellite drift maxima from a synchronous inclined circular orbit due to perturbations are investigated. A synchronous satellite, one which retraces its ground track each day, will tend to drift from the initially synchronous trajectory in time. Six, twelve, and twenty-four hour period orbits receive special attention. Author

N65-33886*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

A LUNAR AND PLANETARY PETROGRAPHY EXPERIMENT

Alden A. Loomis 1 Sep. 1965 27 p refs
(Contract NAS7-100)
(NASA-CR-64917; JPL-TR-32-785) CFSTI: HC $2.00/MF $0.50 CSCL 22A

A preliminary model of a petrographic microscope for lunar and planetary missions has been fabricated. It is designed primarily for remote operation on soft-landing spacecraft, but could be adapted for support of a manned mission. The sample is not a thin section, but an aggregate of crushed rock particles. The images is projected from an air-gapped 16X refracting objective lens through interchangeable eyepiece lenses onto the faceplate of a television camera. The sample particles are thermally encapsulated between two opposing sheets of a clear isotropic thermoplastic (n = 1.54). A television picture is taken both below and above the plane of correct focus as well as in that plane for each field of view in order to change the Becke line positions. Each grain is viewed in both plane-polarized and cross-polarized light; the spectral width is small enough to provide dark and light interference rings on a black-and-white TV. The primary use of the microscope is observation of rock textures. Secondary uses are determination of bulk mineralogy, observation and compositional estimation of glass, identification of phases which occur in small amounts, and identification of the different rock or mineral types in an originally particulate sample. Author

N65-33902# RAND Corp., Santa Monica, Calif.

ECLIPSE OBSERVATIONS FROM THE MOON AND CISLUNAR SPACE

G. F. Schilling and R. C. Moore [1965] 22 p refs Presented at the Lunar Intern. Lab. Symp., 16th Astronautical Congr., Athens, 16 Sep. 1965
(P-3130; AD-618360)

Observing eclipses of the sun and earth from the moon will present unique opportunities for performing valuable scientific experiments. Even during the early phases of lunar exploration, such observational data can be obtained most easily, efficiently, and economically by human observers using very simple instruments. It should be noted that a coordinated program of simultaneous eclipse observations from the earth, from the moon, and from orbiting manned spacecraft, would produce a wealth of scientific data for studies in solar physics, geophysics, astronomy, meteorology, relativity theory, and other fields. Inadequacies in present eclipse theories, unfortunately, do not permit rigorous solutions for the luminous characteristics of the eclipsing and eclipsed bodies as they would appear to observers on the moon or in cislunar space. Nevertheless, quantitative data on the brightness of the earth's halo at specific distances from within the terrestrial shadow-cone have been obtained by a novel method that combines refraction and multiple scattering theory with observed twilight phenomena. Author

N65-33906# Holman (John F.) and Co., Inc., Washington, D. C.

SURVEY OF CELESTIAL BODIES, PHOTOGRAMMETRY AND INTERPRETATION OF PHOTOGRAPHS DURING COSMIC INVESTIGATIONS [S'YEMKA NEBESNYKH TEL, FOTOGRAMMETRIYA I DESHIFRIROVANIYE SNIMKOV PRI KOSMICHESKIKH ISSLEDOVANIYAKH]

G. B. Gonin Fort Belvoir, Va., Army Eng. Res. and Develop. Labs., Aug. 1965 27 p refs Transl. into ENGLISH from the book "Spetsial'nyye Voprosy Fotogrammetrii" Moscow, Izd. Akad. Nauk SSSR, 1964 p 5-20
(Contract DA-44-009-AMC-930(T))
(ERDL-T-1793-65; AD-618666)

The report discusses the photography of celestial bodies of the solar system from rockets, interplanetary stations and artifical satellites, cosmic mapping, photogrammetry, and the interpretation of photographs obtained in cosmic space. TAB

N65-33919*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.

ABSENCE OF MARTIAN RADIATION BELTS AND IMPLICATIONS THEREOF

J. A. Van Allen, L. A. Frank, S. M. Krimigis, and H. K. Hills Aug. 1965 30 p refs *Its* Rept.-65-30
(Grant NsG-233)
(NASA-CR-64870) CFSTI: HC $2.00/MF $0.50 CSCL 03B

A system of sensitive particle detectors on Mariner IV showed the presence of electrons of energy $E_e > 40$ keV out to a radial distance of 165,000 km in the morning fringe of the earth's magnetosphere but failed to detect any such electrons whatever during the close encounter with Mars on July 14–15, 1965, for which the minimum areocentric radial distance was 13,200 km. This result is interpreted to mean that the ratio of the magnetic dipole moment of Mars to that of the earth M_M/M_E is surely less than 0.001 and probably less than 0.0005. The corresponding upper limits on the equatorial magnetic field at the surface of Mars are 200 and 100 gammas, respectively. It appears possible that the solar wind interacts directly with the Martian atmosphere. Author

N65-33922*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ELECTRON MICROPROBE STUDIES OF MICROMETEORITES

Richard A. Schmidt [1965] 8 p Presented at the Cosmic Chem. Sect. of the 20th Intern. Congr. on Pure and Appl. Chem., Moscow, 12–18 Jul. 1965
(NASA-TM-X-56789) CFSTI: HC $1.00/MF $0.50 CSCL 04A

Samples of fine particles presumed to be of cosmic origin were collected from polar ice caps, deep-sea sediments, soil, the atmosphere, and ancient rocks, and then chemically analyzed using electron microprobe techniques in order to investigate the chemical composition of extraterrestrial matter. Characteristic X-ray intensities for the samples were compared

to X-rays of chemically analyzed standard materials. Photographs of examples from four groups of spherules are shown, and the chemical composition of particles in each group are tabulated. An experiment was conducted in which a Ni–Fe steel projectile was impacted against a block of the same composition. The compositional data were tabulated. No chemical changes were noted in the target, or in deformed material; but severe chemical fractionation took place in the spherule to produce a particle with essentially the same composition as the bulk of natural first group spherules. Thus the mechanism of spherule formation appears to be approximated by hypervelocity impact experiments, in which oxidation of Fe to magnetite and loss of Ni occurs in a fashion similar to that displayed in natural spherules. L.S.

N65-33955*# National Aeronautics and Space Administration, Washington, D. C.
SPACE STUDY IN THE SOVIET UNION [ISSLEDOVANIYE KOSMICHESKOGO PROTRANSTVA V SSSR]
G. A. Skuridin May 1965 20 p Transl. into ENGLISH from a paper presented at the 2d Ann. Meeting of the Am. Astronautics Soc., Chicago, 4–7 May 1965
(NASA-TT-F-9540) CFSTI: HC $1.00/MF $0.50 CSCL 22A

A narrative documentary deals with space studies and accomplishments in the Soviet Union. Scientific apparatus carried on the Elecktron 1 and 2 satellites is described, and coordinates are tabulated of those trajectory sectors where sporadic electron flows were recorded. A table presents the results of flow measurements of charged nuclei recorded for three space vehicles during periods of maximum solar activity. The intensity of cosmic radioemissions and various findings from Kosmos 3 and 4 are discussed. M.W.R.

N65-33956*# National Aeronautics and Space Administration, Washington, D. C.
AN ANALYSIS OF FLIGHT TRAJECTORIES TO THE MOON, MARS AND VENUS [ANALIZ TRAYEKTORIY POLETA K LUNE, MARSU I VENERE]
I. K. Bazhinov May 1965 20 p Transl. into ENGLISH from a paper presented at the 2d Ann. Meeting of the Am. Astronautics Soc., Chicago, 4–7 May 1965
(NASA-TT-F-9541) CFSTI: HC $1.00/MF $0.50 CSCL 22A

The report discusses the calculation of circumnavigation or landing orbits with vertical take-off and landing. Parameters, boundary-values and planes are examined and results presented as isolines. Author

N65-33962*# Consultants and Designers, Inc., Arlington, Va.
STUDY OF THE ELONGATION OF HORNS OF THE VENUS CRESCENT IN JUNE 1964 [ETUDE DE L'ALLONGEMENT DES CORNES DU CROISSANT DE VENUS EN JUIN 1964]
Audouin Dollfuss and Eric Maurice 21 Jun. 1965 8 p Transl. into ENGLISH from Comp. Rend. Acad. Sci. (Paris), v. 260, Groupe 3, 11 Jan. 1965
(Contract NAS5-3760)
(NASA-TT-F-9685; ST-OA-10343) CFSTI: HC $1.00/MF $0.50 CSCL 03B

The photometry of the aureole prolonging the horns of Venus at inferior conjunction indicates that the atmosphere above the cloud layer remains charged of particles of approximately 1.5μ in diameter, whose number decreases by a factor of 2 approximately every 2.8 km and whose diffusion coefficient is 3.10^{-8} stilb/phot per centimeter cube contrary to the Sun at the level of the cloud layer. Author

N65-33965*# Consultants and Designers, Inc., Arlington, Va.
ALTERATION OF LUNAR SOIL'S POLARIZING PROPERTIES BY THE ACTION OF SOLAR PROTONS [L'ALTERATION DES PROPRIETES POLARIMETRIQUES DU SOL LUNAIRE PAR L'ACTION DE PROTONS SOLAIRES]
Audquin Dollfuss and John E. Geake 23 Sep. 1965 6 p refs Transl. into ENGLISH from Comp. Rend. Acad. Sci., Selenographie (Paris), v. 260, 10 May 1965 p 4921–4923
(Contract NAS5-3760)
(NASA-TT-F-9901; ST-LPS-CC-10389) CFSTI: HC $1.00/MF $0.50 CSCL 03B

The photometric and polarimetric characteristics of lunar soil can be modified by solar wind-produced proton bombardment. Some of the mineral matters in powdered state acquire under proton bombardment polarizing properties almost identical to those of lunar soil. Author

N65-34013# Naval Ordnance Lab., White Oak, Md.
MAGNETIC MOMENT TESTING OF SATELLITES
Milton H. Lackey, Jr. 18 Jan. 1965 32 p
(NOLTR-64-52; AD-618477)

This report concerns procedures for determining the equivalent magnetic dipole of satellites. A bar magnet was used to simulate the magnetism of a satellite. Data was collected using present satellite test procedures. Results were plotted and compared with mathematically derived curves. Curves similar to these can be used in conjunction with certain test procedures to determine the equivalent magnetic dipole of satellites. Author

N65-34080 Library of Congress, Washington, D. C. Aerospace Technology Div.
INTERSTELLAR COMMUNICATIONS
Vladimir Mutschall *In its* Foreign Sci. Bull., V. 1, No. 9 Sep. 1965 p 56–63 refs (See N65-34075 22-34)

Various Soviet approaches to the interstellar communications problem are discussed, and scientific speculations are included on the number of stars with planets; on what percentage of those planets could be inhabited by plants and animals; and on how many may be expected to have animals with intelligence comparable to our own. Tabular data are given for the distance between civilizations as a function of the number of civilizations; and on the distance between civilizations in light years and the possible types of contacts between civilizations. Three types of theoretical contact between civilizations are discussed: direct contact or reciprocal visits; contacts through communications channels; and combination type contacts which involve sending automatic programmed devices to a planetary system, with the information sent back or stored until the device returns to earth. M.G.J.

N65-34142# Library of Congress, Washington, D. C. Aerospace Technology Div.
LUNAR DIMENSIONS, ANNOTATED BIBLIOGRAPHY Surveys of Soviet-Bloc Scientific and Technical Literature
30 Jul. 1965 25 p
(ATD-B-65-60; AD-619882)

An annotated bibliography of 42 Soviet-bloc research papers on lunar dimensions is presented. It reflects developments from about 1963 in investigations of lunar revolution, rotation, libration, and mapping techniques. G.G.

N65-34195# Joint Publications Research Service, Washington, D. C.
VELOCITY PROFILE OF THE MOON
V. Sh. Berikashvili, V. N. Zharkov, and T. B. Yanovskaya 28 Sep. 1965 21 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Zemli (Moscow), no. 7, Jul. 1965 p 9–21 (JPRS-32167; TT-65-32660) CFSTI: $1.00

Velocity distributions of the P- and S-waves in the interior of the moon were investigated. Evaluation of experimental data on the effects of pressure, temperature, and composition on the velocity of elastic waves in rocks, as well as data on the distribution of P- and S-waves in the upper layers of the earth were used. Also considered were the following specific physical properties of the moon's interior: (1) structure in the presence of a liquid core, stratification, and the layer of reduced velocities; (2) temperature distribution; and (3) distribution of the substance with respect to the chemical composition Hodographs were computed for the various adduced velocity profiles and are shown. It was found that the moon must have an anomalously wide layer of low velocities since the critical temperature gradient for the formation of the layer of low velocities is proportional to the gravity acceleration of the moon's low gravity. The probability of a violation of the Weichert condition in the interior of the moon was held negligible. G.G.

N65-34236*# Consultants and Designers, Inc., Arlington, Va.
DETECTION OF RADIO EMISSION OF THE EXCITED HYDROGEN LINE IN THE NGC 6618 (OMEGA) NEBULA [OBNARUZHENIYE V TUMANNOSTI NGC 6618 (OMEGA) RADIOIZLUCHENIYA LINII VOZBUZHDENNOGO VODORODA]
R. L. Sorochenko and E. V. Borozdich 7 Sep. 1965 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 163, no. 3, 1965 p 603–605
(Contract NAS5-3760)
(NASA-TT-F-9698; ST-RA-10381) CFSTI: HC $1.00/MF $0.50 CSCL 03B

This paper gives the description of the observations with the aid of the 22-meter radiotelescope of the Institute of Physics of the USSR Academy of Sciences, conducted in the spring–summer of 1964. Their object consisted in the detection of the excited hydrogen line conditioned by transitions between the atomic levels with principal quantum numbers 91 and 90. Three facts are cited, which constitute evidence of the detection of excited hydrogen line in the nebula NGC 6618. Author

N65-34333# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
NATURAL AND INDUCED ENVIRONMENTS OF NEAR-EARTH, CISLUNAR, AND DEEP SPACE, AND THEIR EFFECTS ON SPACECRAFT
Donald D. Carlson and George Mac Farlane Aug. 1965 110 p refs
(AEDC-TR-65-108; AD-469015)

This report describes the characteristic parameters that comprise the environment of the various regions of space. The term "space environment" is defined first, and this is followed by a qualitative description of the major regions of space. The environmental parameters of each of these regions, and the importance of each parameter relative to its effect upon the ability of a space vehicle to perform its assigned mission, are then discussed in detail. Author

N65-34356# Royal Greenwich Observatory, Herstmonceux (England).
MEASUREMENTS OF RADIAL VELOCITY FROM COUDE PLATES
Richard Woolley and G. A. Harding London, HMSO, 1965 21 p refs *Its* Roy. Obs. Bull. No. 93 CFSTI: HC $1.00/MF $0.50

Star spectra radial velocity measurements with dispersions between 4.3 and 15.6 A/mm were taken with the coudé spectrographs at Mount Wilson, Palomar, and Radcliffe observatories. The measurements, presented in tabular form, were taken by direct observation of the shift between corresponding star and comparison-arc lines, without reference to accurate wavelengths. Twenty-eight of the 96 stars measured had "a" quality velocities in Wilson's catalog, and a comparison is made between the two series. Velocities for individual components of 12 double stars are included, giving a mean of +0.5 km/s ±0.4 s.e. Observations of five variables in the Hyades cluster are listed, together with eight observations of four other stars in van Bueren's list for determination of membership. In addition spectra of the moon were taken on the various spectrographs and measured to examine the zero of the system. A mean residual of +0.1 s.e. was obtained. G.A.L.

N65-34358# Bologna Univ. (Italy). National Radio Astronomy Lab.
A CATALOGUE OF RADIOSOURCES FROM DECLINATION −30° TO −20° AT 408 Mc/s
A. Braccesi, M. Ceccarelli, R. Fanti, G. Gelato, C. Giovannini et al [1965] 37 p CFSTI: HC $2.00/MF $0.50

Observations have been made with the E-W arm of the cross radiotelescope at the National Radio Astronomy Laboratory, starting from the minimum declination attainable, to be continued up to the North Pole. The object of this survey is to produce a complete list of sources at the frequency of 408 Mc/s and down to fluxes of about one flux unit, for use in problems of cosmological statistics. Reported are the results obtained from the first observations in a region of 10 × 150 square degrees from $\delta = -30°$ to $-20°$ and R.A. 03^h00^m to 13^h00^m. A description of the instrument, and data reduction, and a comparison of the measurements taken with Parkes catalog are included. G.A.L.

N65-34373# Texas Univ., Austin.
A SOLAR SYSTEM EPHEMERIS FOR 1950 TO 2000
James Roger Clark (M.S. Thesis) May 1965 102 p refs
(AD-618545)

Three computer programs were written to provide a means of using the available ephemeris data in numerical studies of the motions of celestial bodies. These programs are written in Fortran 63 language for use on the CDC 1604 digital computer. The main program Phemeris is an interpolation subroutine which provides the user with rectangular coordinates and rectangular components of the velocity of any one or all of the major bodies of the solar system. The information may be obtained in a coordinate system referenced to the mean equinox and equator of 1950 or to the equinox and ecliptic of 1950. The reference frame may be centered in the Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, Moon, or at the Earth–Moon Barycenter. In addition the nutation and nutation rate in longitude and obliquity are made available. The information may be obtained for any time point between 30 December 1959 and 5 January 2000 with an accuracy of 12 figures. Author

N65-34382 Utrecht Observatory (Netherlands).
THE EXTREME LIMB OF THE SUN
J. R. W. Heintze 1965 92 p refs *Its* Recherches Astronomiques, Vol. XVII, No. 2

This investigation is an attempt to find the complete center limb variation at 5 wavelengths, viz 4605, 4910, 5200, 5700, and 6430 A°. A series of 37 flash spectra, obtained during

the solar eclipse of June 30, 1954, were reduced. Data concerning the observation post and the instrumental set-up are given. Although part of the calibration data showed some fog, reliable calibration curves for the flash spectra were constructed. The intensity variation of 13 Bailey beads was followed about 15 seconds before and after totality; the derivatives of these curves were found to coincide satisfactorily. These intensity profiles, corresponding with an interval of 3000 km at the extreme limb, show a limb brightening. The temperature distribution for the photosphere and lower chromosphere is given and explains the intensity profiles. W.M.R.

N65-34389*# National Aeronautics and Space Administration, Washington, D. C.
OPPORTUNITIES FOR PARTICIPATION IN SPACE FLIGHT INVESTIGATIONS
Jul. 1965 116 p
(NASA-TM-X-56801; NHB-8030.1) CFSTI: HC $4.00/MF $0.75 CSCL 22A

An announcement designed to inform the scientific community of opportunities for participation in manned- and unmanned- space flight investigations, is reported. Presented are guidance and background information for use in the preparation of proposals, and data on the primary objectives of the following programs: Orbiting Solar Observatory; Advanced Orbiting Solar Observatory; Surveyor (missions K through Q); Lunar Orbiter Selenodesy; 1971 Voyager Mission to Mars; TIROS; Nimbus; Interrogation, Recording, and Locating Subsystem (IRLS); X-15A2 Research Airplane; Convair 990A Research Airplane; Office of Space Science and Applications (OSSA) Scientific Balloon Program; Explorers; Sounding Rocket, and Manned Space Science Program. S.C.W.

N65-34390*# Philco Corp., Palo Alto, Calif. WDL Div.
TRAJECTORY AND GUIDANCE ANALYSIS. COMET AND CLOSE-APPROACH ASTEROID MISSION STUDY, VOLUME 3 Final Report, 2 Jul. 1964–2 Jan. 1965
Reece Jensen 2 Jan. 1965 131 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950870)
(NASA-CR-67086; WDL-TR-2366) CFSTI: HC $4.00/MF $1.00 CSCL 22A

Short-period comets were surveyed to determine which are best suited for a fly-by mission in the years 1967 to 1975. The comets selected for additional study, primarily on the basis of required injection energy, were then investigated in more detail to determine guidance requirements, recovery problems and other trajectory characteristics. From the accumulated data, a single mission was selected for comparison with the Mariner-C Mars mission. It was concluded that a launch to the comet Pons-Winnecke may be accomplished in late 1969 to early 1970 using an Atlas/Agena/Mariner-C combination. Eros, a close-approach asteroid was also chosen for a possible fly-by mission, primarily on the basis of its size and energy requirements. L.S.

N65-34460*# IIT Research Inst., Chicago, Ill.
AN ANALYSIS OF GRAVITY ASSISTED TRAJECTORIES IN THE ECLIPTIC PLANE
J. Niehoff 25 May 1965 74 p refs
(Contract NASr-65(06))
(NASA-CR-67163; T-12) CFSTI: HC $3.00/MF $0.75 CSCL 22C

A parametric trajectory study of gravity assisted Earth launched trajectories has been conducted. A two-dimensional solar system with circular planetary orbits (except Mercury) is assumed. Gravity assist is restricted to one body between launch and target intercept. Analytical expressions and results are presented for maximum velocity and energy changes available to a spacecraft through gravity assist. A review of the Earth-Venus-Mercury mission is considered after which primary emphasis is placed upon Jupiter, both as a target and as a gravity assisting body. Jupiter fly-bys are found to be attractive for solar probe missions and flights to the outer planets. Included in the results of the study are several examples of launch opportunities for gravity assisted trajectories. Author

N65-34466*# California Univ., Los Angeles.
DYNAMICS OF FLEXIBLE GRAVITY-GRADIENT SATELLITES
Gordon S. Reiter (Ph.D. Thesis) 1965 140 p refs
(Grant NsG-237-62)
(NASA-CR-64731) CFSTI: HC $4.00/MF $1.00 CSCL 22C

Three specific problems relating to flexible gravity gradient satellites in circular orbit are examined: the stability of infinitesimal and noninfinitesimal amplitude angular motions for a class of flexible satellites; static behavior of long wires and rods attached to satellites; and pitch libration of a wire satellite. It was found that a significant range of inertia configurations which were stable for a rigid body were unstable for a flexible body with damping. Also, it was found that the inertia configurations for which finite, purely planar pitch motion was unstable have counterparts in the case of a flexible satellite. The static behavior of flexible satellite appendages was examined on a preliminary basis. Results showed that large-deflection beam theory was required if satellite appendages were sufficiently long; the planar pitching motion of a passive reflector satellite in the shape of a long wire was examined. Libration damping through parametric excitation of damped elastic motion appears feasible if the wire was sufficiently long. R.W.H.

N65-34494# Manchester Univ. (England). Dept. of Astronomy.
PHOTOGRAPHY OF EXTENDED ASTRONOMICAL RADIO EMISSION REGIONS
J. Meaburn Jul. 1964 82 p refs
(Contract AF 61(052)-694)
(AFCRL-65-134; AD-620046)

Techniques and results of filter photography of gaseous nebulae and extended galactic radio sources are presented. An investigation was conducted on the problem of producing large diameter interference filters, and involved the development of a constant molecular emission pattern source and the development of a method to use it to maximum advantage in the large filter production problem. Work was also conducted on the effect on structure of the cryolite spacing layers of 25 interference filters of a variety of thermal conditions. Using these filters, more than 20 radio emission regions in the galactic plane were photographed at Hα, OII, and OIII to investigate spectral differences between Hα regions and supernovae remnants. Large radio loops that project from the galactic plane were photographed mainly at Hα. The results of the photography on the North Polar Spur suggest that there is an extensive Hα emission region associated with this object. A camera was made that will convert the 43 inch f/3.2 Pic-du-Midi reflecting telescope into an f/1 camera. Off-axis aberration calculations in the system leads to the production of a single curve from which the off-axis aberrations of general systems of confocal paraboloids can be calculated. R.N.A.

N65-34506*# Stanford Univ., Calif.
MAGNETIC ATTITUDE CONTROL OF RIGID, AXIALLY SYMMETRIC, SPINNING SATELLITES IN CIRCULAR EARTH ORBITS
Phillip C. Wheeler Washington, NASA, Oct. 1965 218 p refs (Grant NsG-133-61)
(NASA-CR-313) CFSTI: HC $6.00/MF $1.25 CSCL 22C

This dissertation reports a study of the attitude control of spinning satellites in circular earth orbits by means of passing current through a single coil on board the vehicle. The interaction between this current and the earth's magnetic field produces control torques. A new and practical magnetic control law is presented and shown to produce (in the absence of disturbances) asymptotic stability, from arbitrarily large initial attitude errors and vehicle angular velocities, for any circular orbit and any desired spin-axis direction. Accurate estimates of the performance of this control system are obtained by using a combination of Krylov-Bogoliubov averaging and other heuristic techniques, supported by simulation studies. These estimates place in evidence the influence of control system parameters, orbital parameters, and the desired spin-axis direction upon system performance. The usefulness of this magnetic control law is demonstrated by general discussions of its mechanization and, finally, by its application to a representative mission. Author

N65-34546# Osservatorio Astrofisico, Asiago (Italy).
RESEARCHES ON NEBULAR VARIABLES AND FLARE STARS Final Report
L Rosino [1964] 25 p refs
(Grant AF-EOAR-63-95)
(AFCRL-65-180; AD-620049)

Studies on nebular variables and flare stars observed in the Orion, Pleiades, h and X Persei, NGC 7635, and 57 Cygni nebula complexes are reported. Slit and objective prism spectra of several stars imbedded in the nebulosities were obtained; and light-curves and rapid variations in the brightness of stars associated with the Orion complex were derived. A general discussion of the characters of the Orion variables is given. The survey of new variables extended down to magnitude 21 in the Trapezium region of the Orion complex, and it is suggested that an extension of the survey to magnitude 21 will give a better knowledge of the luminosity function, which is now indeterminate in the faint limit. L.S.

N65-34694# Lockheed Missiles and Space Co., Sunnyvale, Calif.
ENVIRONMENTAL EFFECTS ON SPACE STRUCTURES
R. L. Keeney Apr. 1964 80 p refs
(LMSC-6-74-64-17; AD-618030)

Estimates of the nature and magnitude of environmental effects caused by space vacuum, radiation, and meteoric particles on spacecraft structures are presented. Methods to counteract the deleterious effects of the space environment on spacecraft structures and their contents are discussed and preferable ones recommended. The level of reliability of available data is evaluated so that areas of potential future improvement may be identified. It is pointed out that more definite data on meteoroid flux and penetration, and on radiation energy levels and frequency will result in a more precise structural design. R.W.H.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N65-33609* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLIGHT REENTRY EXPERIMENTS
Herbert A. Wilson, Jr. and Robert L. Wright *In* Va. Polytech Inst. Role of Simulation in Space Technol., Pt. B [1964] 26 p (See N65-33604 22-30) CFSTI: HC $6.00/MF $1.50

Flight reentry research in terms of techniques used to investigate reentry environment, radio attenuation, materials behavior, and observable phenomena is discussed. The way in which flight testing supplements, extends, and reinforces the usefulness of data from ground test facilities is shown. The portions of the reentry flight spectrum which can be simulated by hot and cold ground facilities are reviewed, and some of the flight programs for obtaining data in the Apollo reentry envelope are discussed. The programs are categorized as to environment (heating), materials response, communication problems, and observables. A discussion of the launch vehicles, unknown parameters, and methods of data acquisition for each program is presented. C.T.C.

N65-33612* Michigan Univ., Ann Arbor.
COMPUTERS FOR SIMULATION OF SPACE VEHICLE SYSTEMS
R. M. Howe *In* Va. Polytech. Inst. The Role of Simulation in Space Technol., Pt. C [1964] 21 p refs (See N65-33611 22-30) CFSTI: HC $6.00/MF $1.50

The simulation of space vehicle systems presents various computer problems, depending on the scope of the particular simulation. Many simulation problems, including some real-time problems, are amenable to all-digital solution. Others are more suitable for all-analog mechanization. There is a large class of problems best solved on hybrid computer systems, although the programming complexity in such a mechanization should not be overlooked. It is indicated that whatever type of computer system is used, one must choose appropriate axis systems in writing equations of motion so that required computer precision and speed are minimized. R.R.D.

N65-33615* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC SIMULATORS FOR TEST OF SPACE VEHICLE ATTITUDE CONTROL SYSTEMS
G. Allan Smith *In* Va. Polytech. Inst. The Role of Simulation in Space Technol., Pt. C [1964] 30 p refs (See N65-33611 22-30) CFSTI: HC $6.00/MF $1.50

The design and use of airbearing platforms for space vehicle attitude control system studies and tests are discussed. It is shown that the airbearing platform provides a mounting of extremely low friction with wide orientation capability. Although it does not duplicate the zero gravity effect, it can permit sensitive balance to bring the center of gravity very close to the center of rotation and minimize pendulous effects. It is concluded that the airbearing platform permits an accurate representation of spacecraft inertia and realistic use of the actual vehicle attitude control torque sources and sensors. R.R.D.

N65-33632# Inter-Range Instrumentation Group, White Sands Missile Range, N. Mex. Meteorological Working Group.
THE METEOROLOGICAL ROCKET NETWORK
El Paso, Tex. Western Coll., Feb. 1965 305 p refs
(IRIG-111-64; AD-464583)

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13. UPPER ATMOSPHERIC TEMPERATURE SENSING USING THE BEAM THERMISTOR G. O. Clark and J. G. Mc Coy (Army Electron. Res. and Develop.) p 259–272 (See N65-33645 22-31)

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16. A METHOD FOR COMPUTING BALLISTIC WIND DATA FOR APPLICATION TO ARCAS LAUNCHER SETTINGS O. H. Daniel (Pan Am. World Airways, Inc.) p 301–306 (See N65-33648 22-20)

17. METEOROLOGICAL ROCKET NETWORK DATA REDUCTION J. E. Morris (Army Electron. Res. and Develop.) p 307–312 (See N65-33649 22-20)

N65-33634 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
ARCAS METEOROLOGICAL SOUNDING ROCKET
Kenneth R. Jenkins *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 157–168 (See N65-33632 22-31)

A short review of the Arcas design and application as a reliable tool for meteorological research in the upper atmosphere is presented. The Arcas design incorporates low acceleration, long burn time, and a generally adequate payload volume. The principal weakness of the system is its sensitivity to wind, resulting in a requirement for precise ballistic analysis prior to launching. The Arcas rocket system has been the major vehicle to gather temperature data in the region from 25 to 65 kilometers; its Robin configuration uses an internal reflector for passive radar tracking purposes; and its parachute system generally provides satisfactory wind data from 200,000 feet above mean sea level downward. A statistical evaluation of over Arcas flights is shown in a chart. G.G.

N65-33635 Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.
THE ARCAS METEOROLOGICAL ROCKET
Robert Leviton *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 169–180 (See N65-33632 22-31)

The two basic configurations of the Arcas sounding rocket are described. One design consists of a small rocket-sonde package, carried in the nose cone, which, upon ejection at flight apogee, descends on a 15-foot radar-reflective parachute and sends back temperature information by telemetry. The other payload design incorporates the Robin falling sphere, a 1-meter-diameter radar-reflective plastic balloon, that is also ejected at apogee to help obtain space-time data. A closed breech launcher is normally used for launching of the Arcas rocket, but an auxiliary gas generator can be utilized. A discussion of some of the improvements incorporated into the Arcas system is included; modifications in nozzle insulation, positioning of the fins, various bonds, etc., are described in brief form. G.G.

N65-33636 Naval Ordnance Lab., White Oak, Md.
THE HASP METEOROLOGICAL ROCKET SYSTEM
M. J. Parker *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 181–190 (See N65-33632 22-31)

High altitude sounding projectiles (HASP) designate a family of small, single-stage, solid-propellant, meteorological sounding rockets that are used to gather data on wind speed, wind direction, and temperature of the upper atmosphere. The HASP system consists of the rocket itself, a launching system, and data systems. The instrumental HASP III body contains a parachute, and a radiosonde set attached to the parachute line. This radiosonde collects and transmits temperature data to a ground receptor. General flight characteristics for HASP II rockets with payloads of chaff, or with a parachute, and for HASP III rockets carrying a parachute-radiosonde payload, are shown in a table. G.G.

N65-33637 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
THE JUDI METEOROLOGICAL ROCKET SYSTEM
Robert O. Olsen *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 191–200 (See N65-33632 22-31)

Described is the Judi meteorological rocket system that is used for atmospheric soundings between 30 and 60 kilometer heights. Depending on the payload, this system is capable of measuring winds, pressure, temperature, and density as a function of altitude. It is comprised of two stages: the Judi booster motor, and the unpowered dart which carries the payload. When the rocket velocity reaches 4,900 feet per second, the dart separates from the motor and coasts to an altitude in excess of 250,000 feet. Short descriptions of the following Judi configurations are given: (1) chaff dart vehicles; (2) parachute dart vehicle; (3) balloon dart vehicle; and (4) instrument dart vehicle. The chaff dart configuration is most extensively used and has an operating level of 96% in acquisition of useful wind data. G.G.

N65-33638 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.

THE RAVEN METEOROLOGICAL ROCKET

Otto W. Thiele *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 201–210 (See N65-33632 22-31)

Several meteorological soundings above 200,000 feet were obtained with a Raven sounding rocket system. This system utilizes an internal 8.5-second duration, 1800-pound thrust unit; its payload separation device consists of a modified Judi-Dart 135-second pyrotechnic delay expulsion charge. Some of the advantages of this rocket are its much lower wind sensitivity, simplicity of launching, accessibility of payload after the rocket is loaded on the rail, and conservation of battery life because of the reduced lead time required for final payload preparation and installation. Evaluation of its flight history established a stability problem near burnout. It was concluded, that the present Raven configuration can carry a 17- to 20-pound payload from a launch elevation of 4,000 feet to an altitude of approximately 220,000 feet. G.G.

N65-33639 Aberdeen Proving Ground, Md. Army Ballistic Research Labs.

HIGH ALTITUDE GUN PROBE SYSTEMS FOR METEOROLOGICAL MEASUREMENTS

John A. Brown and Spence T. Marks *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 211–222 (See N65-33632 22-31)

Development and testing of a 5-inch gun probe system was reported. An improved gun probe system with external bracing was used to eject chaff and parachutes for high altitude wind measurements at 240,000 feet. An effort to eject an inflatable drag sphere failed due to premature fuze detonation. The construction of a 7-inch gun probe system was completed, and horizontal testing was started. A 16-inch gun probe system was used to place 50-pound payloads to altitudes in excess of 400,000 feet, and wind velocity profiles of two successful tri-methyl aluminum trailing probes are shown. Development of improved wind sensors, particularly in the field of improved parachute designs, for use with these systems is in progress. G.G.

N65-33640 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.

BOOSTED ARCAS AND BOOSTED RAVEN SYSTEMS FOR HIGH ALTITUDE SOUNDINGS

Otto W. Thiele *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 223–228 (See N65-33632 22-31)

Several booster motors were tried in connection with the Arcas rocket in order to reach altitudes considerably above 100 km, and a Sparrow-Arcas configuration reached apogee altitudes of 520,000 and 507,000 feet for the Arcas second stages. Two Boosted Raven systems using Sidewinder motors as boosters, and carrying 25 and 30-pound payload weights, were also successfully fired, and reached predicted heights of 371,000 and 370,000 feet altitude. It was concluded that the use of large boosters with the Arcas and Raven rockets is feasible for carrying small payloads to altitudes well above 200,000 feet. G.G.

N65-33641 Pacific Missile Range, Point Mugu, Calif.

THE DENPRO (SPARROW-HV-ARCAS) VEHICLE

J. E. Masterson and R. A. Wallston *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 229–234 (See N65-33632 22-31)

A modified Arcas rocket with a Sparrow booster was developed and tested for carrying payloads, capable of measuring density by the pitot tube gage technique, on the ascending leg of the rocket trajectory between altitudes of 140,000 and 350,000 feet. Two complete density payloads were flown and ranging data were obtained on both flights. Of two additional flights with inflatable 26-inch diameter metalized spheres as payloads in the nose cones of the rocket configurations, one was successful. The ejected sphere was tracked by radar, and density and temperature data were derived on both the upleg and the downleg trajectory. G.G.

N65-33645 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.

UPPER ATMOSPHERIC TEMPERATURE SENSING USING THE BEAD THERMISTOR

George Q. Clark and John G. Mc Coy *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 259–272 (See N65-33632 22-31)

Theoretical studies and actual measurements showed that bead thermistors coated with KRYLON (pigment 89 percent TiO_2) were excellent sensors of atmospheric temperatures after being ejected from a hot rocket nose cone environment. Analyses of the first data obtained with the glass-coated 10 mil bead thermistor indicated that it was imperative to place the bead in the environment ahead of the sonde's wake. A sensor mounting scheme is shown, where the thermistor protrudes forward into the null zone of the dipole transmitting antenna to minimize the effect of RF heating. Described also is the Delta telemetry and ground equipment system together with its data reduction procedures. This system was used to make measurements of atmospheric temperatures from 65 kilometers down, with an accuracy to ±2% at 60 kilometers. G.G.

N6F 33646 Pan American World Airways, Inc., Patrick AFB, Fla.

THE ARCASONDE 1A ROCKET RADIOSONDE

O. H. Daniel *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 273–276 (See N65-33632 22-31)

The temperature sensor subassembly for the Arcasonde 1A is presented. It contains a coated bead thermistor of 0.01 inches diameter, and minimizes error sources by providing high surface areas in conjunction with low thermal mass, highly reflective surfaces to ward off incident thermal radiation, and a resonant transmission line at transmitter frequencies. The Arcasonde is a completely integrated payload intended for

obtaining atmospheric temperature versus altitude profiles from approximately 200,000 feet downward to impact upon the earth's surface. G.G.

N65-33647 Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.
THE ROBIN FALLING SPHERE
John B. Wright *In* Inter-Range Instrumentation Group Meteorol. Rocket Network Feb. 1965 p 277-297 (See N65-33632 22-31)

Described is the configuration, sequence of operation, and space-time history of the inflatable Robin falling sphere that is used as meteorological sensor in connection with the Arcas sounding rocket. Reliability of the current Arcas-Robin system was found to be about 70 percent, with some indication of deterioration when the units had one and one-half to two years of shelf age. Also discussed are the procedures of the standard Robin computer program that are used to reduce a complete 12-minute sounding of radar data in approximately two minutes. Proposed new Robin system refinements are briefly outlined. G.G.

N65-33805*# National Aeronautics and Space Administration, Washington, D. C.
RECENT DEVELOPMENT AND PERSPECTIVES OF COMMUNICATIONS SATELLITES [EVOLUTION RECENTE ET PERSPECTIVES DES SATELLITES DE TELECOMMUNICATIONS]
V. A. Altovsky Sep. 1965 44 p Transl. into ENGLISH from FRENCH Presented at the 5th European Space Symp., Munich, Jul. 1965
(NASA-TT-F-9555) CFSTI: HC $2.00/MF $0.50 CSCL 22B

A review of existing communications satellites, including TELSTAR, RELAY, SYNCOM, EARLY BIRD, MOLNYA, etc., with tabulated data on worldwide coverage of the systems, main characteristics, and orbital aspects, is followed by a brief discussion of European projects and future participation in US projects. Advantages of phased and clustered systems are compared, and European preference for 24-hour orbit systems is emphasized. A French project of a three-orbit system with groups of 4-5 satellites each and a 12-hour circular orbit at 20 400 km is described briefly. Author

N65-33831*# National Aeronautics and Space Administration, Washington, D. C.
ELECTRICAL POWER MANAGEMENT SURVEY MANUAL
1 Sep. 1965 33 p
(NASA-SP-6007; CM-019-002-1) CFSTI: HC $2.00/MF $0.50 CSCL 05A

The Electrical Power Management Survey Manual provides procedures for a management audit of NASA Apollo Program contractor activities, assesses performance towards objectives, evaluates effectiveness of the management system, and where weaknesses exist, it provides a tool for determining corrective action. This amplifies Electrical Power Management Standard NASA SP-6005, June 15, 1965

N65-33881*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
LUNAR ORBITER CAPSULE Preliminary Configuration Report
25 Sep. 1962 68 p Prepared for JPL
(NASA-CR-64898; AED-1616) CFSTI: HC $3.00/MF $0.75 CSCL 22B

The general mission objectives and design criteria to be used tin governing the various system choices for a lunar orbiter capsule study are delineated. The results of a previous trade-off study, along with recommendations for specific configurations of the retropulsion, attitude control, telecommunications, television, and power supply subsystems for the capsule are presented. L.S.

N65-33885*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
SATURN ILLUSTRATED CHRONOLOGY. SATURN'S FIRST EIGHT YEARS, APRIL 1957-APRIL 1965
15 May 1965 154 p Revised
(NASA-TM-X-56798; MHR-4) CFSTI: HC $5.00/MF $1.00 CSCL 22D

The origin of the Saturn project is traced from its inception in April 1957, through the various development phases that culminated in several successful launchings. The major program milestones are discussed, and data on the mission objectives, characteristics, and major contractors are tabulated. The configurations, test stands, engine models, assembly and installation procedures, recovery concepts, facilities construction, mockup stages, launch complexes, proposed solid propellant boosters, and actual launch photographs are representative of the illustrations included. M.G.J.

N65-33948# France. Office National d'Etudes et de Recherches Aérospatiales, Chatillon-sous-Bagneux.
ATTITUDE CONTROL IN A NEAR SPACE PROBE MISSION [CONTROLE D'ATTITUDE D'UNE SONDE SPATIALE A MISSION PROCHE]
Marcel Bismut and André Remondière 1965 37 p In FRENCH Presented at the 16th Intern. Astronautical Congr., Athens, 12-18 Sep. 1965
(ONERA-TP-271) CFSTI: HC $2.00/MF $0.50

An automatic attitude control system was developed for sounding rockets of various sizes and aerodynamic characteristics. It is intended for explorations in near space, and has been used successfully with the Tacite rocket.
Transl. by J.M.D.

N65-34198# Sandia Corp., Albuquerque, N. Mex.
PROJECT SAND. VOLUME III: DYNAMIC ANALYSIS OF THE SAND SAMPLER FLIGHT Final Program Report
H. R. Vaughn and D. Q. Matejka Sep. 1965 70 p refs Sponsored by AEC
(SC-RR-65-286) CFSTI: $3.00

A dynamic analysis of flight RY-15 of the SAND sampler is presented. The structural failure of the sampling vanes is shown to have resulted from resonance of the first bending mode with the payload oscillatory motion. Author

N65-34223*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
ELECTRONIC INTEGRATION OF THE UK-1 INTERNATIONAL IONOSPHERE SATELLITE
J. M. Turkiewicz, C. F. Fuechsel, R. G. Martin, F. D. Piazza, and V. L. Krueger Washington, NASA, Sep. 1965 43 p refs
(NASA-TN-D-3001) CFSTI: HC $2.00/MF $0.50 CSCL 22B

The first International Ionosphere Satellite was launched on 26 April 1962, and carried experiments designed to increase knowledge of the ionosphere and its complex relation to the sun. The on-board experiments included ion and electron studies by probes, an electron density experiment, measurements of Lyman-alpha and x-ray solar radiation, and

cosmic ray measurements. The program was a joint United States–United Kingdom project. This report describes the spacecraft, its various subsystems, and the techniques used in integration. An evaluation of the performance of the various systems during testing and launching is also given. Author

N65-34244*# Aerojet-General Corp., Azusa, Calif.
ENGINE OPERATING PROBLEMS IN SPACE: THE SPACE ENVIRONMENT
D. Christensen Washington, NASA, Sep. 1965 227 p refs
(Contract NAS7-98)
(NASA-CR-294) CFSTI: HC $6.00/MF $1.50 CSCL 22A

This volume presents a comprehensive definition of the space environment as it is presently known. For the purpose of this program, this environment consists of the solar system, excluding the earth and its inner atmosphere. Special emphasis is given to data on electromagnetic and particulate radiation, meteoroid flux, and the structure and composition of the planetary atmospheres. A list of 405 references is included; many of these are annotated. Author

N65-34339# Army Missile Command, Huntsville, Ala. Mechanical and Electrical Design Branch.
DEVELOPMENT OF A RECOVERY BODY FOR THE AMRAD PROJECT
H. C. Tom 15 Aug. 1965 40 p refs
(ARPA Order 198; Proj. Defender)
(RS-TR-65-6; AD-469695)

This report describes the design and development of the recovery body which is used to return a tape recorder containing valuable research data from a suborbital missile flight flown to investigate radar re-entry phenomena. Both impact-type bodies utilizing no deceleration devices or location aids and parachute-type recovery bodies were evaluated. The final design was a recoverable nose cone utilizing a colored, radar-reflective, metallized parachute, a radio beacon, and a flashing light (for night missions) as recovery aids. High-altitude drop tests from 45 000 feet under nighttime conditions confirmed the workability of the design. Author

N65-34425*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLIGHT PARAMETERS AND VEHICLE PERFORMANCE FOR PROJECT FIRE FLIGHT I, LAUNCHED APRIL 14, 1964
William I. Scallion and John H. Lewis, Jr. Washington, NASA, Sep. 1965 96 p refs
(NASA-TN-D-2996) CFSTI: HC $3.00/MF $0.75 CSCL 22B

Project Fire has been undertaken by the National Aeronautics and Space Administration to investigate the heating environment of vehicles entering the earth's atmosphere at velocities slightly higher than return velocities from a lunar mission. This project was accomplished by using an Atlas D launch vehicle in conjunction with an Antares II-A5 solid-propellant rocket motor which successfully placed a blunt-nosed reentry vehicle into the desired reentry environment. Sufficient data were obtained from the supporting systems to define closely the overall trajectory and the characteristics of the atmosphere through which the experiment was conducted. Author

N65-34433*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
UTILIZATION OF AN ORBITAL LAUNCH FACILITY FOR PLANETARY MISSIONS
Robert M. Croft 14 Sep. 1965 62 p refs
(NASA-TM-X-53311) CFSTI: HC $3.00/MF $0.75 CSCL 22D

This report presents the results of a study conducted to determine the feasibility, from an orbital mechanics viewpoint, of utilizing a permanent Orbital Launch Facility (OLF) to support missions to Mars and Venus during the 1975–1990 time period. Twenty-seven Earth departure windows were selected for Mars and Venus missions in the 15-year period. The required nodal orientation a vehicle must have for a coplanar injection into an Earth escape trajectory was calculated for each of the Earth departure windows. An arbitrarily-chosen OLF orbit was then projected through all the 27 windows. This OLF orbit was completely compatible with all Earth departure windows except two, and was compatible with these two with only minor additional velocity requirements. Author

N65-34610* Aerospace Corp., El Segundo, Calif.
THE EFFECT OF CHARGED-PARTICLE ENVIRONMENTS ON MANNED MILITARY SPACE SYSTEMS
F. L. Keller and R. G. Pruett *In* NASA, Washington 2d Symp. on Protec. Against Radiations in Space 1965 p 265–286 refs
(See N65-34575 22-29) GPO: $3.25 CFSTI: MF $2.50

Charged particle radiation hazards to men in spacecraft are evaluated with respect to geomagnetically trapped radiation, galactic cosmic rays, and solar flares. The earth's trapped radiation belts constitute a definite threat to manned satellites orbiting as far away as several thousand nautical miles. Polar orbiting satellites could encounter solar proton bursts which would force deorbit or descent to lower altitude. Vehicle shielding for Manned Orbital Laboratory radiation safety need not exceed 5 g/cm^2 in thickness. Low-Z material is recommended for spacecraft outermost surface where electrons and bremsstrahlung made a large contribution to the total dose. J.M.D.

N65-34617* North American Aviation, Inc., El Segundo, Calif.
APOLLO SPACE NUCLEAR RADIATION PROTECTION STATUS REPORT
Frederick Raymes *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 365–375 refs
(See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Radiation protection for astronauts in Command/Service Modules is evaluated. In particular, the hazards due to solar radiation during Apollo lunar missions are discussed. Based on radiation dose calculations, it is concluded that the men in the Command/Service Module will be adequately protected. Protection against unusual levels of radiation in the coming solar cycle can be developed through utilization of a warning system, particular spacecraft orientation, and dose reduction by means of spot shielding. J.M.D.

N65-34619* Lockheed-California Co., Burbank.
A SPACE RADIATION PROTECTION SYSTEM FOR NEAR-EARTH MANNED ORBITAL SPACE STATIONS
Frank L. Bouguet, Jr. *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 397–405 refs
(See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

Protection of personnel in space stations operating in the near-earth environment from the hazards of high speed meteoroids and high energy particles is investigated. Shield thicknesses and weights required for protection for a large three-spoke space station were computed for circular orbits and one-year missions. The helmet, suit, and bunk shielding weights are found to be minimal. Little shielding is necessary for low orbital altitudes, but the weight requirements increase rapidly for altitudes above 125 nautical miles. It is concluded

that radiation fields in space will not prohibit operation of near-earth space stations in low altitude, low inclination orbits planned for the coming decade. J.M.D.

N65-34621* Douglas Aircraft Co., Santa Monica, Calif.
SHIELDING REQUIREMENTS FOR MANNED ORBITING SPACE STATIONS
T. M. Jordan, E. F. Koprowski, and R. W. Langley *In* NASA, Washington 2d Symp. on Protec. against Radiations in Space 1965 p 415–427 refs (See N65-34575 22-29) GPO: $3.25; CFSTI: MF $2.50

A detailed parametric investigation of radiation shielding requirements was performed for first generation manned orbiting space stations. Two specific space station designs were studied; the results of the shielding analysis are based on the actual geometry of the vehicles, onboard equipment, and supplies. Results are presented for circular orbits ranging from 100 to 600 nautical miles and from 20° to 90° inclination. The effects of the geometry of the space stations, the use of personal shielding, and the use of particular shielding materials are discussed. Author

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N65-33616* National Aeronautics and Space Administration, Washington, D. C.
INTRODUCTION TO THE SESSION ON STRUCTURAL DYNAMICS
I. E. Garrick *In* Va. Polytech. Inst. The Role of Simulation in Space Technol., Pt. C [1964] 2 p (See N65-33611 22-30) CFSTI: HC $6.00/MF $1.50

A brief discussion is presented on the role of simulation in structural dynamics for space technology. It includes a description of lectures dealing with space vehicles, launch vehicles, and payloads, on the ground and in space. The role of simulation in space technology is to reduce costs and ensure reliability of the final products. R.R.D.

N65-33617* National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.
PRINCIPLES AND PRACTICES FOR SIMULATION OF STRUCTURAL DYNAMICS OF SPACE VEHICLES
George W. Brooks *In* Va. Polytech. Inst. The Role of Simulation in Space Technol., Pt. C [1964] 46 p refs (See N65-33611 22-30) CFSTI: HC $6.00/MF $1.50

The paper discusses the philosophy and principles for the selection and design of dynamic models for analysis of structural dynamics of space vehicles. Subjects treated include similitude, model scaling, applications of modeling to launch vehicles and spacecraft, and considerations relative to damping and model support systems. An appendix is included which summarizes the various dimensionless ratios used in aerospace flight. Author

N65-33619* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
SIMULATION OF STRUCTURAL DYNAMICS OF SPACE VEHICLES DURING LAUNCH
H. L. Runyan *In* Va. Polytech. Inst. The Role of Simulation in Space Technol., Pt. C [1964] 40 p refs (See N65-33611 22-30) CFSTI: HC $6.00/MF $1.25

Simulation techniques in the design and operation of launch vehicles are reviewed, with emphasis on dynamic problems from the time of lift-off to the time at which the vehicles leave the atmosphere. Figures are presented of most of the launch vehicles now in use or soon to be operational. Except for the Scout, all vehicles are liquid propelled, thin skinned, and present many interesting and baffling dynamic problems during their ascent through the hostile atmosphere. Dynamic modeling techniques are very often mandatory in the solution of such problems R.R.D.

N65-33625*# Virginia Polytechnic Inst., Blacksburg.
THE ROLE OF SIMULATION IN SPACE TECHNOLOGY, PART D
[1964] 236 p refs Proc. of Conf. held on 17–21 Aug. 1964 *Its* Eng. Extension Ser. Circ. No. 4
(Contract NASr-226)
(NASA-CR-64815) CFSTI: HC $6.00/MF $1.25 CSCL 20K

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N65-33626* Hughes Aircraft Co., Culver City, Calif.
SIMULATION OF THE STRUCTURAL DYNAMICS OF SPACECRAFT DURING LUNAR LANDING
John M. Bozajian *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. D [1964] 28 p ref Prepared for JPL (See N65-33625 22-32) CFSTI: HC $6.00/MF $1.25
(Contracts NAS7-100; JPL-950056)

Current methods of simulation utilized in development of a landing system for a lunar soft-landing spacecraft are presented. The technology is based on the Surveyor, an unmanned, lunar spacecraft being developed by the Hughes Aircraft Company for NASA under contract to the Jet Propulsion Laboratory. A brief general description of Surveyor, its mission and three-legged configuration are discussed. The functional requirements of the landing system are described with respect to both lunar surface and vehicle touchdown conditions. A landing dynamics computer program has been used to determine toppling stability and results are shown for a range of lunar surface and spacecraft parameters. Scaling parameters for earth gravity testing are reviewed. Author

N65-33659* Texas A&M Univ., College Station.
A GENERAL THEORY OF THIN ELASTIC SHELLS OF PLANE ANISOTROPIC MATERIALS
Harry J. Sweet *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 59 p refs (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

General thin shell equations are derived for plane anisotropic materials. The equations are presented in terms of the three components of the middle surface displacement of the shell. A complete set of equations is also given for the determination of the solution to the shell problem for any shell shape. Three-dimensional coordinate axis diagrams are presented depicting the parts of the shell element for which equations from the derivation are applicable. Topics discussed with reference to shells include surfaces, symmetry, stress-strain, rotation, and displacement. L.S.

N65-33660* Texas A&M Univ., College Station.
DYNAMIC ENERGY ABSORPTION CHARACTERISTICS OF AN ALUMINUM FRANGIBLE TUBE
W. B. Ledbetter and C. H. Samson, Jr. *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 13 p refs (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

Dynamic and static characteristics, including energy absorption and peak franging force under selected conditions are analyzed and correlated for an aluminum fragible tube. Tube geometry, die tolerance, and type of test used were varied. The length to outside diameter ratio (L/D) of each tube, the static loading rate, the dynamic energy input per square inch of tube area, the aluminum tubing material used, and the geometry of the franged end of the tube were all held constant. Dynamic franging-load versus tube-franging-deformation plots are presented. The load-deformation phenomenon is highly irregular. At the initial peak load the tube fractures by franging at the die end, causing the load to drop momentarily. As the franging continues, the load vacillates up and down, varying in magnitudes of 2000 or more pounds. Thus for the purposes of data analysis, the average franging forces are plotted also. The franging force for each tube size, and the average energy absorbed per inch of tube length are in the process of being analyzed. L.S.

N65-33661* Texas A&M Univ., College Station.
SOLUTIONS OF ELASTICITY PROBLEMS USING BOUNDARY CONDITIONS OBTAINED EXPERIMENTALLY
J. G. H. Thompson *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 17 p (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

A conductive sheet method of producing stress trajectories for providing a practical means of solution to difficult stress-analysis problems, such as stresses in irregular-shaped bodies, is discussed. A brief summary of the digital computer program designed to solve a set of partial differential equations for the method is presented. The technique is described, and is applied to the problems of a square plate in compression on a diagonal, a circular ring in compression on a diameter, a beam in pure bending, a split ring in compression across the split end, and a pinned strip in tension. The results were in very good agreement with theory and litesature findings determined by other experimental methods. Also included are diagrams depicting the isotropic point in the region interior, on a line of symmetry, and on a boundary. L.S.

N65-33730# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
EFFECTS OF STRAIN-GRADIENT ON STRESS-CONCENTRATION AT A CYLINDRICAL HOLE IN AN ELASTIC SOLID
Nachman N. Eshel Jun. 1965 44 p refs
(Contract Nonr-4259(13))
(TR-2; AD-468199)

The solution of the problem of a cylindrical hole in a field of simple tension is obtained in the linear theory of elasticity in which the potential energy-density depends on both the strain and the gradient of the strain. The stress-concentration factor at the surface of the cylindrical hole is found and it is compared with the analogous results obtained in couple-stress theory and in classical elasticity. Author

N65-33733# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics
EFFECTS OF MICRO-STRUCTURE ON THE STRESS CONCENTRATION AT A SPHERICAL CAVITY
J. L. Bleustein Feb. 1965 44 p refs
(Contract Nonr-266(09))
(TR-54; AD-468198)

In this paper the boundary-value problem for the stress concentration at a spherical cavity in a field of isotropic tension is solved within the framework of Mindlin's theory of an elastic continuum with a deformable micro-structure. It is found that the stress concentration factor is moderately larger than the 3/2 of classical elasticity for a wide range of material properties and ratios of radius of cavity to a length parameter of the material—with a critical ratio, nearly independent of the remaining material properties, for which the stress concentration factor is a maximum. Author

N65-33734# Columbia Univ., New York. Inst. for the Study of Fatigue and Reliability.
ON FATIGUE FAILURE OF A MULTIPLE-LOAD-PATH REDUNDANT STRUCTURE
A. M. Freudenthal and M. Shinozuka Jun. 1965 29 p refs
(Contract Nonr-266(91))
(TR-20; AD-467857)

It is difficult to evaluate the survivorship or reliability function of a structure subject to fatigue consisting of a number of members from the survivorship functions of a single specimen that can be obtained from experiment. An attempt is therefore made to establish the upper and lower bounds of such a survivorship function under the assumption of constant amplitude fatigue and equal distribution of the load among the existing members, approximating the real process of the failure by Markovian processes. A numerical example employing the data of fatigue tests performed on 7075 Aluminum alloy single specimens indicates that the order of magnitude of the life of a composite structure can be reasonably well predicted by the estimate of the bounds according to the present method. Author

N65-33766# Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences.
AN INVESTIGATION OF THE BEHAVIOR OF FLOATING RING DAMPERS AND THE DYNAMICS OF HYPERCRITICAL SHAFTS ON FLEXIBLE SUPPORTS Final Report, 1 Jul. 1963–15 Sep. 1964
J. A. Friedericy, R. T. Eppink, Y. N. Liu, and A. Cetiner Ft. Eustis, Va., Army Aviation Materiel Labs., Jun. 1965 122 p refs
(Grant DA-AMC-44-177-63-G10)
(UVA-CE-3340-104-65U; USAAML-TR-65-34; AD-619156)

This report deals with the development of two different analyses for the vibration responses in supercritical shafts: one especially suited for the determination of support impedances (mass, spring, damping coefficients) for minimum vibration response in the criticals; the other for direct vibration response in terms of statically measured shaft defects. The traveling wave concept is extensively discussed. Presented is a preliminary parameter study of the simply supported rotating shaft with one flexible intermediate support subjected to a half sine wave defects distribution. The effects of end masses are studied also. Several conceptual designs of multiring damping assemblies which can accommodate the damping requirements of hypercritical shafts are included in the report. Author

N65-33804*# National Aeronautics and Space Administration, Washington, D. C.
NONLINEAR PROBLEMS OF STRESS CONCENTRATION NEAR HOLES IN PLATES [NELINEYNYYE ZADACHI KONTSENTRATSII NAPRYAZHENIY OKOLO OTVERSTIY V PLASTINAKH]
G. N. Savin Sep. 1965 39 p refs Transl. into ENGLISH from Tr. Iv Vsesoyuznoy Konf. po Teorii Obolochek i Plastin, 24–31 Oktyabr' 1962 (Yerevan), 1964 p 116–140
(NASA-TT-F-9549) CFSTI: HC $2.00/MF $0.50 CSCL 20K

This survey of 36 papers and monographs, dealing with nonlinear problems of stress concentration near holes in plates, places special emphasis on solution methods employing complex potentials in conjunction with conformal mapping and Cauchy integrals. Applications of these techniques to the following stress concentration situations are discussed: stress concentration near an elliptical hole; effects of hole reinforcement by means of elastic rings; and stress concentration near free and reinforced curvilinear holes. A brief description of results obtained on the pattern of the stress condition near the hole in an elastic flexible plate following its postcritical deformation, is included. G.G.

N65-33841*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
COMPARISON OF METHODS IN CALCULATING FREQUENCIES OF CORNER-SUPPORTED RECTANGULAR PLATES
Robert E. Reed, Jr. Washington, NASA, Sep. 1965 36 p refs
(NASA-TN-D-3030) CFSTI: HC $2.00/MF $0.50 CSCL 20K

The lower natural frequencies of a rectangular plate that is pin supported at the corners are found analytically by two approximate methods. The first is the Ritz method and the second is a series solution to the differential equation of motion. These frequencies are also found experimentally for comparison. All of the results are presented along with some previous work done by other authors using a finite difference method. Some of the advantages and disadvantages of the two methods pertaining to the numerical computations are discussed. Author

N65-33856*# General Motors Corp., Santa Barbara, Calif. Aerospace Operations Dept.
RESEARCH ON THE PROPERTIES OF OPTIMUM METEOROID SHIELDS Summary Report
C. L. Meyers and J. A. Charest Sep. 1964 108 p refs
(Contract NAS8-11118)
(NASA-CR-64934; TR64-48) CFSTI: HC $4.00/MF $0.75 CSCL 20K

Experimental studies on the measurements of shock-pressure maximum amplitudes, momentum transfer, and phenomenological models of crater formation are reported. The following four regimes were considered: (1) the initial transient regime of cratering, including impact flash; (2) the primary penetration regime of cratering in which the projectile acts on the target as a causative force; (3) the cavitation regime of catering in which the pressure on the crater surface decreases; and (4) the recovery regime of cratering, including surface spallation and release of pressure on the crater walls. Detailed experimental data covering the last three regimes are presented, and the materials and experimental equipment used are described in appendices. G.G.

N65-33914# Illinois Univ., Urbana. Dept. of Aeronautical and Astronautical Engineering.
RESPONSE OF MULTI-SPANNED BEAM AND PANEL SYSTEMS UNDER NOISE EXCITATION Technical Report, Jun. 1964–Sep. 1964
Y. K. Lin Wright-Patterson AFB, Ohio, AF Mater. Lab., Feb. 1965 48 p refs
(Contract AF 33(657)-11715)
(AFML-TR-64-348, Pt. I; AD-614830)

A statistical theory is presented for the stationary and nonstationary response of a system of multispanned beams and a system of multispanned panels under noise excitation. The intermediate supports of the beam and panel systems are, respectively, elastic springs and elastic stringers. The matrices of frequency response functions are obtained from the transfer matrices which represent the mechanism that transmits the displacements and forces at one location of the systems to another. The effects of the structural and acoustic dampings and of the acoustic apparent mass are accounted for in the formulation. Author

N65-33918*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
A REVIEW OF CUMULATIVE DAMAGE FOR FATIGUE COMMITTEE OF THE STRUCTURES AND MATERIALS PANEL ADVISORY GROUP FOR AERONAUTICAL RESEARCH AND DEVELOPMENT
Herbert F. Hardrath [1965] 17 p refs Presented at the AGARD, Munich, 14 Jun. 1965
(NASA-TM-X-56749) CFSTI: HC $1.00/MF $0.50 CSCL 20K

The analysis of any practical fatigue problem almost invariably involves some consideration of the progressive accumulation of damage due to loads that vary in amplitude. It is the purpose of this paper to review the current state of the art of such analysis and to make recommendations for future action. Advance copies of the review were submitted to other members of the Fatigue Committee and their associates for comment. The writer gratefully acknowledges their contributions and several of these have been included in the present version of the report. Author

N65-33970*# Northrop Space Labs., Huntsville, Ala. Research and Analysis Section.
DYNAMIC STABILITY ANALYSIS OF A FREE-FREE CIRCULAR CYLINDRICAL SHELL SUBJECTED TO A GIMBALED, PERIODICALLY-VARYING END THRUST Technical Memorandum No. 101
C. M. Pearson, J. H. Kincaid, and A. D. Merville Aug. 1965 141 p refs
(Contract NAS8-11255)
(NASA-CR-67077; E20-115) CFSTI: HC $4.00/MF $1.00 CSCL 20K

The dynamic structural behavior of a large rocket booster during powered flight, idealized as a free-free thin walled cylinder, is investigated. The investigation represents a continuation of an earlier analysis. Powered flight simulation is produced by a gimbaled time varying end thrust controlled by sensors located at the center of mass. The additional instabilities reported in the stability analysis section represent the coupling effect from consideration of beam action not considered in the previous analysis. R.N.A.

N65-33985# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
CREEP ANALYSIS OF CIRCULAR PLATES BY ENERGY METHODS
James Bentson, Sharad A. Patel, and B. Venkatraman Jun. 1965 19 p refs
(Contract AF 49(638)-1360)
(PIBAL-698; AFOSR-65-0985; AD-618310)

The present paper investigates the creep bending of circular plates using energy theorems of elasticity. Firstly, the theorem of minimum potential energy is used to derive, in terms of rectangular coordinates, the governing differential equations and the natural boundary condition for laterally loaded thin plates. Next, these equations are transformed into polar coordinates for application to rotationally symmetric circular plate problems. For such plates, the theorem of minimum total complementary potential is then used to derive the governing moment equation and the corresponding boundary conditions. This is followed by a brief discussion of Reissner's variational theorem as applied to circular plates problems. The use of each of these three theorems is then illustrated by obtaining solutions to the problem of a simply supported circular plate. Finally, these solutions are graphically compared with exact solutions obtained previously. Author

N65-34039# Southwest Research Inst., San Antonio, Tex. Dept. of Mechanical Sciences.
A REVIEW OF THE STATE-OF-THE-ART OF VIBRATION DAMPING ASSOCIATED WITH SHIP HULL STRUCTURES
William E. Woolam Feb. 1965 87 p refs
(Contract Nonr-4597(00)(X))
(TR-1; AD-464311)

A review of the existing knowledge of damping of ship-hull vibrations is presented with emphasis on values of damping coefficients of full-size ships. The contributions of various damping mechanisms to the over-all damping coefficient have been investigated in detail. The literature indicates that the predominant sources of damping in order of importance are: (1) cargo; (2) structural; and (3) hydrodynamic damping. The results of the study indicate that values for the damping parameter are still inadequate and that present methods of measuring damping should be evaluated in more detail to provide consistent results. Author

N65-34040# Southwest Research Inst., San Antonio, Tex. Dept. of Mechanical Sciences.
A THEORETICAL AND EXPERIMENTAL STUDY OF STRUCTURAL VIBRATION CHARACTERISTICS OF SUBMERGED HYDROFOILS. PHASE III-A: VIBRATION ANALYSIS OF A TYPICAL, FULL-SCALE HYDROFOIL CRAFT
Jack. T. Irick and Carl G. Langner Apr. 1965 116 p refs
(Contract N600(167)-60477(X))
(TR-2; AD-464844)

The results of a theoretical procedure to calculate the free-free natural frequencies and mode shapes of a hydrofoil craft are presented. The procedure is essentially an influence coefficient method using matrix theory. The PC(H)-1 hydrofoil was chosen becuase the lumped parameter approximation to the continuous system was readily available from previous theoretical analyses of the craft. In previous analyses the vibration characteristics of the foil systems and the hull were calculated separately. These calculated characteristics are reproduced using the influence coefficient approach, and the coupled natural frequencies of the entire coupled hull-foil system are calculated. Results are presented for both the displaced and foil-borne conditions. Results show that the influence of the hull on the natural frequencies of the foil is so great as to place in doubt the interpretation and design utility of results of previous analyses which treat the vibration and flutter characteristics of foil systems attached to a rigid foundation. R.N.A.

N65-34043# General Technology Corp., Elgin, Ill.
STRESS ANALYSIS OF TWO INTERSECTING CYLINDRICAL SHELLS Quarterly Progress Reports No. 16 and 17, 20 Apr.–20 Dec. 1964
[1964] 8 p
(Contract NObs-90157)
(AD-464347)

A sign error was found in the computations of the bending stress M_ϕ. This affects the values of the stress concentration factor at the inner and outer surfaces only. The structure of these curves is essentially the same as the ones previously reported with the exception of the changing of the positions of maximum stress. It was shown that as $\beta_{\rho o}$ increases the maximum S_c occurs first on the outer surface for $\beta_{\rho o} \leq .35$ and then on the lower surface for $\beta_{\rho o} > .35$. R.W.H.

N65-34046# Aerospace Corp., El Segundo, Calif.
FREE VIBRATIONS OF A UNIFORM BEAM UNDER CONSTANT END TANGENTIAL THRUST
Paul Seide 29 Oct. 1964 15 p ref
(Contract AF 04(695)-469)
(TOR-469(5560-30)-2; AD-464820)

The free vibrations of a uniform beam subjected to constant end tangential thrust are studied. The tangential load is found to affect the vibration frequencies much less than if the load had a constant axial direction. The critical load for tangential loading is more than four times that for axial loading. Author

N65-34054# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
THE POSTBUCKLING EQUILIBRIUM OF AXIALLY COMPRESSED CIRCULAR CYLINDRICAL SHELLS
Nicholas J. Hoff, Wayne A. Madsen, and J. Mayers Feb. 1965 40 p refs
(Contract AF 49(638)-1276)
(SUDAER-221; AFOSR-65-0643; AD-616999)

Earlier numerical solutions of the von Kármán–Donnell large displacement equations for thin circular cylindrical shells have been extended by considering larger numbers of terms in the double Fourier series representing the radial displacements after buckling. In the most comprehensive one of the calculations whose results are presented here a total potential energy expression consisting of about 1100 terms was minimized with respect to 16 unknowns. The results of the computations as well as theoretical considerations indicate that the solution for long shells of the von Kármán–Donnell equations with the aid of the von Kármán–Tsien–Leggett procedure leads in the limit to the trivial solution in which

the amplitude of the displacements tends to zero, the number of waves around the circumference tends to infinity and the average axial compressive stress capable of maintaining equilibrium in the postbuckling state tends to zero. Author

N65-34126*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
THOR-AGENA LATERAL BENDING VIBRATION ANALYSIS Final Report
R. S. Nowek and E. L. Stanton 5 Jul. 1965 133 p refs
(Contract NAS1-5156)
(NASA-CR-64971; SM-48944) CFSTI: HC $4.00/MF $1.00
CSCL 22B

A lateral bending vibration analysis for the first three structural modes of a Thor-Agena test vehicle, being tested at the Langley Research Center, is presented in this report. The analysis includes the effects of rotary inertia, transverse shear and propellant sloshing. Numerical results were obtained using a standard Douglas program (DBIL) on the IBM 7094 computer. Author

N65-34135# Air Force Systems Command, Wright Patterson AFB, Ohio. Air Force Materials Lab.
LARGE DEFLECTIONS OF STATICALLY LOADED COPLANAR FIBERS USING NORMAL AND TANGENTIAL DISPLACEMENTS Technical Report, Jun.–Dec. 1964
James M. Whitney May 1965 30 p refs
(AFML-TR-65-39; AD-619495)

The increased use of fibrous materials in engineering applications makes the quantitative analysis of the mechanical behavior of a statically loaded fiber important. Through an assumed idealized fiber, the analysis of fiber deflection of a thin circular rod subjected to a variety of static loadings. Thin flexible bars easily undergo large deflections; thus elementary strength of materials is not applicable. Even classical theory of linear elasticity because of its assumptions of small displacements is rendered useless. This report deals with two-dimensional deflections of statically loaded thin rods. The purpose is to find the deflected curve as a function of the undeflected shape and the imposed loads. The solution is in terms of normal and tangential displacements from points on the original undeflected curve. Five nonlinear differential equations are derived and solved for several loadings and end conditions on an analog computer. Results are presented in graphical form. Author

N65-34178# Lowell Technological Inst. Research Foundation, Mass.
EFFECTS OF EXTERNAL FORCES ON VIBRATING CRYSTAL PLATES Final Report, 1 May 1963–30 Apr. 1965
Charles R. Mingins, Luther C. Barcus, and Robert W. Perry [1965] 58 p refs
(Contract DA-36-039-AMC-02239(E))
(Rept.-16; AD-619715)

Numerous experimental and theoretical aspects of the reactions of a vibrating piezoelectric plate to the application of external steady forces and torques have been considered in continuing this study of the subject. New material deals with such matters as further illuminating cases of selectively induced force fields, the degree of linearity of tensile forces applied at an azimuthal angle of low sensitivity in frequency, some experiments on torsional stresses, and some curves which evolve from theory. The overall summary covers flexural stress experiments, compression normal to the major faces, the stress coefficient of frequency, tensile stress relationships, the general nature of force field studies, and the relative efficacy of nonlinear and perturbational methods of analysis. Author

N65-34267# Materials Research Lab., Inc., Richton Park, Ill.
FACTORS CONTROLLING THE STRENGTH OF COMPOSITE BODIES (INTERPHASE FRACTURING OF COMPOSITE BODIES) Final Report, Feb. 17, 1964–Mar. 31, 1965
S. Mostovoy and E. J. Ripling [1965] 43 p refs
(Contract NOw-64-0414-c)
(AD-470121)

The fracture toughness of epoxy used in the bulk and adhesive form was measured by a previously developed technique. By varying the ratio of hardener to resin and post-cure temperature on a single epoxy system, it was found that the toughness of the eopxy used in either bulk or bond form varied by a factor of approximately five. A particular combination of composition and post-curing temperatures, where the bonds were very tough, their toughness exceeded that of the bulk material. Hence, it does not appear possible to predict joint toughness from bulk toughness measurements. The toughness of joints was found to be a single valued function of tensile modulus. For the bulk material, on the other hand, the toughness obtained on the epoxy having a specific modulus depended on the combination of composition and post-cure temperature. Joint toughness for any combination of composition and post-cure temperature depended only on the cracking rate. If the epoxy was the type that caused cracks to jump rapidly, the epoxy was tough and vice versa. For a particular epoxy system, toughness was increased by driving the crack at an increasing rate. Author

N65-34277# Forest Products Lab., Madison, Wis.
MINIMUM WEIGHT STRUCTURAL SANDWICH
Edward W. Kuenzi Jan. 1965 17 p refs
(Contract AF 33(657)-63-358; BuWeps Order IPR-19-64-8041-WEPS)
(FPL-086; AD-463592)

This note presents theoretical analyses for determination of dimensions of structural sandwich of minimum weight that will have certain stiffness and load-carrying capabilities. Included is a brief discussion of the resultant minimum weight configurations. Author

N65-34287# Tracor, Inc., Austin, Tex.
STRESS REPORT ON STRUCTURAL MODIFICATIONS OF 669 A ECM POD FOR INSTALLATION OF PHASE I DISPENSERS
Bayard Wilson 1 Mar. 1965 32 p refs
(Contract AF 33(657)-11519)
(TRACOR-65-136-U; AD-461591)

This report presents a stress analysis of structural modifications which were made on two identical center sections of the 669 A ECM pod. The purpose of these modifications is to provide for installation of chaff dispensing units that are suitable for use by the Air Force. The critical loading condition is a 13000 lb jettison force applied 3 inches from the center of gravity of the pod. For this loading and for the following assumed conditions: (1) most critical pod model configuration; (2) fully loaded pod weight; and (3) strength properties weakened by elevated temperature, the margin of safety is shown to be positive and hence adequate for all structural modifications of the pod sections. Author

N65-34295# Aberdeen Proving Ground, Md. Ballistic Research Labs.
HYPERVELOCITY IMPACT: DEPENDENCE OF CRATER DIMENSIONS ON IMPACT VELOCITY
John H. Kineke, Jr. May 1965 13 p refs
(ARPA Order 71)
(BRL-MEMO-1652; AD-469918)

Craters in copper and lead, produced by hypervelocity impact, have been measured and the dimensions correlated with impact velocity. The results indicate that craters scale with about the 1.7 power of velocity, in agreement with computer physics results based upon hydrodynamic calculations. Author

N65-34374*# McDonnell Aircraft Corp., St. Louis, Mo.
CONICAL SHELL DEFLECTION AND ACCELERATION RESPONSE PROGRAM (DARC)
A. T. Brunkow 30 Jul. 1965 218 p refs
(Contract NAS1-3179)
(NASA-CR-66013; B731) CFSTI: HC $6.00/MF $1.25 CSCL 20K

Detailed information is presented for using an IBM 7094 computer program which will calculate the response of truncated conical shells to random pressure excitation such as encountered by spacecraft adapters during a launch trajectory. A normal mode approach is used in the program formulation, with each mode represented by a second order linear oscillator. Options are provided for using either theoretical or experimental vibration model data. The pressure excitation is handled by dividing the shell surface into many small areas and either (1) assuming a different homogeneous pressure over each resulting sub-area, or (2) using empirically determined pressure co-spectra to integrate the equations for each sub-area pair. Author

N65-34391*# Alabama Univ., University. Bureau of Engineering Research.
STABILITY OF SMALL PLASTIC CYLINDERS SUBJECTED TO INTERNAL PRESSURE AND AXIAL COMPRESSION Progress Report No. 3
Thomas A. Carlton, Jr. and Gustavo A. Aramayo Aug. 1965 33 p refs
(Contract NAS8-11155)
(NASA-CR-67102) CFSTI: HC $2.00/MF $0.50 CSCL 20K

An experimental study was conducted to determine the stability of cylindrical shells fabricated from flat sheets of cellulose acetate for verifying theories of shell stability. The unstiffened plastic cylinders were subjected to various combinations of axial compressive load and internal pressure. Results showed that the theory of Lo, Crate, and Schwartz was satisfactory for determining the critical buckling strength of pressurized unstiffened cylinders, provided that the walls behave as a membrane. W.M.R.

N65-34407*# Florida Univ., Gainesville, Fla. Dept. of Engineering Science and Mechanics.
GENERAL INSTABILITY OF CYLINDRICAL SHELLS Final Report
S. Y. Lu and William A. Nash Apr. 1965 97 p refs
(Grant NsG-16-59)
(NASA-CR-67137) CFSTI: HC $3.00/MF $0.75 CSCL 20K

Nonlinear finite deflection theory is employed in an analysis of the general instability of elastic cylindrical shells. Nonlinearity is due to the inclusion of second-order terms in the strain-displacement relations, and linear theory is the limiting case when the deflection is very small. Postbuckling behavior of thin pressurized cylinders subject to bending or compression is investigated; effects of imperfections of pressurized cylinders under compression are considered; and stability of ring-stiffened cylindrical shells under internal pressure and axial compression or bending is discussed. Solutions for all of these were obtained by the Galerkin method, and numerical solutions are given for the first two. The method of minimum potential energy was employed in studies dealing with the problem of buckling of a ring-stiffened shell subjected to external pressure. The effect of surface shear on buckling of cylindrical shells is observed by examination of the compatibility and equilibrium equations. M.W.R.

N65-34435*# McDonnell Aircraft Corp., St. Louis, Mo.
RANDOM PRESSURE EXCITATION OF SHELLS AND STATISTICAL DEPENDENCE EFFECT OF NORMAL MODE RESPONSE
Robert E. Davis Washington, NASA, Sep. 1965 32 p refs
(Contract NAS1-3179)
(NASA-CR-311) CFSTI: HC $2.00/MF $0.50 CSCL 20K

The power spectrum of structural response to random excitation provides a valuable tool for evaluating structural integrity. Using a normal mode approach, equations are derived which give the response power spectrum of shell-type structures to random pressure excitation. Primary assumptions are that the exciting phenomenon is weakly ergodic, and that the structure is lightly damped and its motion is linear. The derivation is carried to a point such that direct solution of the final equations is possible, i.e., imaginary terms are eliminated and the equations are given as functions of positive frequency in cycles per second. The statistical dependence of the normal coordinate responses is accounted for in the equations, rather than being neglected as is usually done. Furthermore, the importance of these terms is investigated and a limiting case on their importance is obtained. Author

N65-34493# New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.
CAVITY EFFECT IN A PRESSURE BAR
F. D. Ju and Kenneth B. Simmons May 1965 124 p refs
(Grant AF-AFOSR-250-64)
(ME-12; AFOSR-SR-65-1074; AD-619820)

The gross effects of a thin cavity in a pressure bar were investigated. Model research was conducted in materials, geometries, controlled measurements, and loading methods. Experiments were also conducted on the cavity bar to study the bar wave reflected and transmitted from the cavity section, the strain field approximate to the cavity region, the fracture mode, and the fracture strength. A PETN explosive compound was decided to be most compatible with the model. Certain control over the explosive was possible to vary the pulse length and the pulse intensity. The strain measurement of non-destructive tests and the fracture surfaces of destructive models showed that the principal axis of stress rotates 10 to 20 degrees toward the axis of revolution. With increasing cavity size, the incident peak strain necessary to produce fracture decreased. However, if the strain levels were corrected for the reduced area at the cavity section, most of this variation was eliminated. R.W.H.

N65-34514# California Univ., Berkeley. Structural Engineering Lab.
CONSTITUTIVE EQUATIONS FOR A CLASS OF NONLINEAR ELASTIC SOLIDS Interim Technical Report

R. J. Evans Jun. 1965 57 p refs *Its* Rept.-65-5
(Grant DA-ARO(D)-31-124-G257)
AROD-4547-1; AD-469186)

Constitutive equations are developed for elastic solids sustaining deformation for which displacement gradients are small but where complete physical nonlinearity is permitted. The constitutive equation includes special cases; at the same time, more general effects are considered, in particular, coupling between volumetric and deviatoric effects. Some simple states of deformation are examined and the plane elastostatic problem is formulated together with the approximate solution of an example by perturbation techniques.
Author

N65-34566# David Taylor Model Basin, Washington, D. C.
GENERAL RESISTANCE TEST OF A STEPLESS PLANING HULL WITH APPLICATION TO A HYDROFOIL CONFIGURATION
Lawrence Benen Jul. 1965 46 p refs
(DTMB-2006; AD-619646)

General resistance tests of TMB Model 4667 were conducted in the Langley Field facility of the David Taylor Model Basin to determine the performance characteristics of one of a series of hulls which might be adaptable for use with hydrofoils. Resistance, trimming moment, and wetted length were measured for several load, trim, and speed conditions. All data are presented in nondimensional form for use in comparing hull forms and calculating takeoff performance. Author

N65-34698*# Northrop Space Labs., Huntsville, Ala. Research and Analysis Section.
VIBRATION OF A CIRCULAR CYLINDRICAL ELASTIC TANK, PARTIALLY FILLED WITH AN INCOMPRESSIBLE FLUID, UNDERGOING AN AXIAL ACCELERATION COMPOSED OF A UNIFORM AND A PERIODIC COMPONENT
Technical Memorandum No. 102
J. G. Goree, G. C. Kao, T. N. Lee, and C. M. Pearson Sep. 1965 63 p refs
(Contract NAS8-11255)
(NASA-CR-67173; E20-116) CFSTI: HC $3.00/MF $0.75 CSCL 20K

The dynamic responses of a circular cylindrical tank partially filled with an incompressible fluid and subjected to a periodically varying longitudinal thrust were analyzed. The variables separation method was used to determine the pressure exerted by the vibrating fluid on the shell wall. Assumptions on the small displacements both on the shell elements and the free surface of the liquid are emphasized so that the linear theory can be applied. By assuming the displacements to be general double series, and using Galerkin's method to solve the shell equations, a system of ordinary differential equations in the time functions $\bar{U}^{(i)}_{mn}(\tau)$, and $\bar{V}^{(i)}_{mn}(\tau)$, and $\bar{W}^{(i)}_{mn}(\tau)$ was obtained. It is proposed to solve this system of equations using Laplace transforms and matrix theory. Because extensive numerical work is involved, the numerical solutions of the time functions, the natural frequencies of the shell-fluid system, and the instability criteria can only be obtained through the aid of an electronic computer. R.N.A.

N65-34704# New York Univ., N. Y. Courant Inst. of Mathematical Sciences
BUCKLING OF A RECTANGULAR COLUMN ON THE BASIS OF MURNAGHAN'S FORMULA FOR STRAIN ENERGY
Samuel Lubkin May 1965 34 p refs
(Contract Nonr-285(46))
(IMM-NYU-340; AD-465772)

Buckling criteria are derived for a rectangular column for large two-dimensional strains, using a strain energy density function suggested by Murnaghan. This function is analogous to the classical density function in that it involved two elastic constants but is simpler in certain respects. Despite the apparent simplicity, the evaluation proved more difficult than the equivalent analysis using the classical function. As expected, Murnaghan's density function leads to smaller values of critical strains than does the classical but the difference is slight for slender columns. For infinitely thick columns, the critical strain is found to range between 0.344 to 0.372 depending upon the ratio of elastic constants as compared to 0.5 for the classical formula independent of this ratio.
Author

N65-34715# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
ANALYSIS OF LARGE DEFLECTIONS IN STRUCTURES
Johnson Andrew Jenkins and Thomas Bingham Seitz (M.S. Thesis) Jun. 1965 151 p refs
(GAM/Mech/65B-8; AD-618727)

The purpose of this investigation is to develop equations which predict the large nonlinear deflections of a diamond-shaped frame subjected to loading in tension or compression. Two frames with different combinations of pinned and fixed joints are analyzed through large deflection nonlinear, small deflection nonlinear, and linear (analytical and matrix) analyses so that a comparison of the theories might be made. The results of the large deflection nonlinear analysis are found to agree very well with actual experimental data. A linear matrix analysis of a multi-bay Vierendeel truss is also developed and compared with experimental data. Author

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N65-33578 Block Engineering, Inc., Cambridge, Mass.
EMISSIVITY OF GRANULAR SURFACES AT RESONANCE FREQUENCIES
Myron J. Block *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 435-440 refs
(See N65-33550 22-13)

Thermal emission spectra of materials are appreciably influenced by resonance reflectivity. In order to evaluate the dependence of the effect on grain size, emission spectra of carborundum abrasives at about 60° C were measured with an interferometer spectrometer. The depth of the spectral gap at the 12.2 micron resonance depends on grit size, and is virtually nonexistent for very fine powders. For coarse grits the cavities between the granules thwart the high reflectivity, and limit the depth of the spectral gap. Author

N65-33586 Washington Univ., Seattle.
THE CONSEQUENCES OF TERRESTRIAL SURFACE INFRARED EMISSIVITY
Konrad J. K. Buettner, Clifford D. Kern, and John F. Cronin (AF Cambridge Res. Labs.) *In* Mich. Univ. Proc. of the 3d Symp. on Remote Sensing of Environment Feb. 1965 p 549–561 refs Prepared jointly with AFCRL, Bedford, Mass. (See N65-33550 22-13)

Three methods of determining surface emissivity are presented: (1) Reflection data from polished samples run on a spectrophotometer, (2) a device called an emissivity box, and (3) emissivity as inferred from the TIROS satellite data. Some geological interpretation of the TIROS data are presented along with values of emissivity determined by the above three methods. Author

N65-33606* Virginia Polytechnic Inst., Blacksburg.
CONVECTIVE AND RADIATIVE HEAT TRANSFER DURING REENTRY AND ADVANCED TECHNIQUES FOR THEIR SIMULATION
Thomas N. Canning *In its* Role of Simulation in Space Technol., Pt. B [1964] 27 p refs (See N65-33604 22-30) CFSTI: HC $6.00/MF $1.50

The use of shock tubes, ballistic ranges, and combinations thereof in the simulation of convective and radiative heat loads are described. Variations in the simple shock tube are discussed, and a brief consideration is given to the expansion tube. Work done in ballistic facilities is presented, and the development of guns capable of firing test bodies at speeds up to 10 km/sec are discussed. The simulation of radiative heating is also considered. C.T.C.

N65-33607* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EVALUATION OF MATERIALS IN ENTRY HEATING SIMULATION
William A. Brooks, Jr. *In* Va. Polytech. Inst. Role of Simulation in Space Technol., Pt. B [1964] 44 p refs (See N65-33604 22-30) CFSTI: HC $6.00/MF $1.50

The effects of several environmental heating parameters such as enthalpy, pressure, heating rate, and aerodynamic shear on the behavior of ablation materials are discussed. Extrapolation of experimental data to an environment considerably more severe than the test environment is also briefly considered. C.T.C.

N65-33656* Texas A&M Univ., College Station.
RADIAL HEAT TRANSFER FROM A PLASMA STREAM
B. T. Eubank and J. R. Johnson *In its* [Interdisciplinary Space-Oriented Res. Program in the Phys., Life, and Eng. Sci.] Aug. 1965 11 p ref (See N65-33655 22-23) CFSTI: HC $6.00/MF $1.25

The modes of forced convection, radiation, and conduction from electrically-generated plasmas of helium, argon, and nitrogen at temperatures up to 15000° K were studied on an experimental heat transfer apparatus constructed and calibrated for calorimetrically determining heat transfer coefficients. Heat from a plasma flame flowing in a circular tube at atmospheric pressure is passed to the inside pipe walls, which are maintained at a low temperature with water as coolant, and the modes of radial heat transfer are measured. Analysis of the experimental data along with a mathematical model which was worked out, indicate that radiation and conduction are not important at the temperature levels investigated, but promise to become so at slightly higher values; that the dependence of the forced convection heat transfer coefficient on the average plasma temperature is nil; and that the coefficient apparently is dependent on the mass flow rate of the plasma stream. L.S.

N65-33718*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PROPELLANT HEATING STUDIES WITH WALL AND NUCLEAR HEATING
B. H. Anderson, S. C. Huntley, and D. J. Connolley Washington, NASA 1964 31 p refs Presented at the ASME Meeting, New York, 29 Nov.–4 Dec. 1964
(NASA-TM-X-52040) CFSTI: HC $2.00/MF $0.50 CSCL 20M

Information obtained on the flow behavior induced by wall and nuclear heating was investigated in three phases. (1) The important factors relating to the basic flow behavior of a confined fluid subjected to wall and simulated nuclear heating, were studied. Nuclear heating was simulated by permitting infrared radiation to be absorbed in a solution of two parts trichloroethane to one part ethyl alcohol. (2) In an analytical study a theoretical flow model was used to predict the liquid temperature gradient as a function of time after the start of flow when a tank is subjected to wall and nuclear testing. (3) A series of liquid hydrogen experiments were performed to investigate the behavior of liquid hydrogen subjected to wall heating, and wall and source heating in a nuclear radiation field. Two distinct regions developed in the main bulk of the fluid: an upper region where the effects of wall heating predominated to form a characteristic stratified layer, and a lower region where source heating dominated to form a uniform temperature profile. R.W.H.

N65-33747# AeroChem Research Labs., Inc., Princeton, N. J.
THICKNESS AND CONDUCTION CORRECTIONS FOR THE THIN-WALLED CALORIMETER
S. A. Gordon Jul. 1963 15 p refs
(Contract AF 33(657)-10341)
(AeroChem-TP-69; AD-463865)

Certain mathematical properties allow the "thin-wall" model of calorimeter response to be extended to rather thick-walled devices when the time rate-of-change of calorimeter temperature is the measurement of interest. Advantage is taken of these properties to obtain first order corrections to the simple theory for those circumstances which do not quite satisfy the simpler requirements. Author

N65-33756# Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Aero Propulsion Lab.
A COMPARISON OF THE CAPABILITIES OF A FUEL COKER AND THE MINEX HEAT EXCHANGER FOR DETERMINING HYDROCARBON FUEL THERMAL STABILITY
Alan E. Zengel Mar. 1965 98 p refs
(AFAPL-TR-64-154; AD-616361)

Hydrocarbon jet fuels degrade at high temperatures to leave lacquer-like deposits on hot surfaces. Presently, a fuel's resistance to thermal degradation is determined by visually rating a color on a tube that has been exposed to hot fuel. Unfortunately, the visual rating is difficult to interpret in terms of such engineering parameters as the effect on heat transfer. In this report, comparisons are made between the visual results obtained with a coker and the results obtained with a small, highly-instrumented Minex heat exchanger. The comparisons show that a reasonable correlation between the results obtained with the heat exchanger and with the coker may be achieved if three or more coker tests are analyzed on the basis of tube wall temperature versus deposit rating. By measuring the thickness of the film deposited and by knowing the effect of this

thickness on heat transfer, a thermal conductivity can be calculated. The study showed that the calculated thermal conductivity was essentially the same for all of the seven fuels tested, the average thermal conductivity being 0.05 Btu/(hr)(ft^2)(° F/ft). Author

N65-33764# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
HEAT TRANSFER CHARACTERISTICS OF NATURALLY COMPACTED SNOW
Yin-chao Yen Jun. 1965 14 p refs
(CRREL-RR-166; AD-619344)

The heat transfer characteristics of naturally compacted snow have been determined experimentally. The results are interpreted as effective thermal conductivity k_e and water vapor diffusivity D_e and can be well represented by

$$k_e = 0.0077(\rho_s)^2 + 0.60\ (G)$$

and

$$D_e = 0.65 + 2113\ (\rho_s)^{3.20}\ (G)^{0.615}$$

In contrast with the results obtained from previous investigations on unconsolidated snow, in the case of naturally compacted snow, values of k_e and D_e are found to be not only a function of air flow rate but also of snow density. From present as well as previous studies, it can be concluded that air flow has considerable effect on the thermal conductivity and water vapor diffusivity of unconsolidated and naturally compacted snow. It is reasonable to state that the essential factor influencing the formation of depth hoar and avalanches is a prolonged process of simultaneous heat and mass transfer due to steep temperature gradients imposed on a snow layer. Author

N65-33792# Thiokol Chemical Corp., Huntsville, Ala.
STUDY OF METEOROLOGICAL ROCKET FALLING MASS HAZARDS Quarterly Technical Report, 5 Oct. 1964–15 Jan. 1965
S. P. Gualillo 1 Mar. 1965 52 p
(Contract DA-01-021-AMC-11453(Z))
(Rept.-321-65; AD-463771)

This program is a feasibility study directed toward demonstration of the fragmentation concept of eliminating the falling mass hazard in the propulsion stage of a meteorological rocket. A motor design has been established with components manufactured from laminated paper-phenolic material. Physical property tests have been conducted on samples of paper-phenolic material to establish the criteria for the motor design. Fragmentation tests have been conducted on the individual components in the system to verify that the components can be properly destroyed to eliminate a falling mass hazard. Detonation propagation tests have been conducted to establish the techniques to be used in applying the explosive sheet to the motor and assuring that proper transfer of detonation will occur at all interfaces. The motor grain configuration has been established and a ballistic analysis conducted. Drawings are being prepared for casting tooling and motor components. Thermal analysis for the nozzle and external heat barriers are in process. Author

N65-33798# Sylvania Electric Products, Inc., Mountain View, Calif. Electronic Defense Labs.
DIRECTIONAL REFLECTANCE AND EMISSIVITY OF AN OPAQUE SURFACE
Fred E. Nicodemus 19 May 1964 32 p refs
(EDL-G266; AD-463473)

Concepts, terminology, and symbols are presented for specifying and relating directional variations in reflectance and emissivity of an opaque surface element. Their relationship to more familiar concepts, including those of perfectly diffuse and spectacular reflectance, is given, and they are applied to illustrative examples. It is shown that, when the usual reciprocity relationship holds, the reflectance for a ray incident on an opaque surface element is related by Kirchhoff's Law to the emissivity of that element for a ray emitted along the same line in the opposite sense. Author

N65-33815*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
HYPERSONIC NONVISCOUS RADIANT GAS FLOW PAST A CONE [OBTEKANIYE KONUSA GIPERZVUKOVYM POTOKOM NEVYAZKOGO ISLUCHAYUSHCHEGO GAZA]
G. A. Kolton 14 Jun. 1965 15 p refs Transl. into ENGLISH from Vestn. Leningr. Univ., Ser. Mat., Mekh. 'Astron.' (Leningrad), v. 2, 1965 p 118–126
(NASA-TT-F-9687; ST-GD-10345) CFSTI: HC $1.00/MF $0.50 CSCL 20M

The effect of a radiant gas on the characteristics of hypersonic flow past a cone is investigated by the "boundary layer" method developed by Freeman, Chernyy, Lyubimov and others. The problem is reduced to a nonlinear integral equation for gas enthalpy, obtained in the extreme case of the flow, and the method for its solution is indicated. This solution allows to determine the shock wave curvature at the leading edge of a cone. Author

N65-33874*# North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.
ENGINEERING METHOD TO PREDICT SATURN V VEHICLE AND LAUNCH COMPLEX ENVIRONMENTS DUE TO ROCKET JET IMPINGEMENT Final Report
A. Africano 29 Jul. 1965 150 p refs
(Contract NAS8-11407)
(NASA-CR-67017; SID-65-816) CFSTI: HC $4.00/MF $1.00 CSCL 20M

Results of investigations are presented on the prediction of forces and heat loads induced by rocket jet plume impingement on typical structures of the Saturn V vehicle and launch complex simulated by flat, cylindrical, and spherical surfaces. Ambient environments of the jet plumes considered ranged from sea level to near vacuum altitudes. Discussions are included on program objectives; environments; special problem areas; jet plume flow fields, approximate descriptions; method of characteristics; influence coefficients for standard jet plumes; jet plume impingement geometry for true angle of streamline impingement on canted and uncanted flat plates and cylinders, and on spheres; impact pressures due to jet plume impingement and contributions of photon impingement, molecular impingement, and impingement of flowing gases; heat transfer due to jet plume impingement including radiation from gaseous and solid particle constituents, radiation from the impingement shock layer, convection heat transfer in the oblique, normal, stagnation, and turbulent flow areas, and the characteristic velocity concept of the heat transfer-impingement pressure relationship. R.N.A.

N65-33892# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
COMBINED CONVECTION AND RADIATION IN RADIOISOTOPE THRUSTORS

James A. Dibiase (M.S. Thesis) Jun. 1965 149 p refs
(GSP-65A/ME/65-1; AD-618026)

Heat transfer by the combined effects of convection and radiation is investigated for radioisotope propulsion systems. Fully developed laminar flow is considered, with the transverse temperature profiles assumed to be the fully developed profiles for the local conditions. The governing equations are derived for non-insulated and insulated systems and the equations are solved numerically on an IBM 7094 computer. The assumptions used in the theoretical analysis are tested experimentally for the insulated case by simulating the radioisotope with a resistance heater and using hydrogen as a propellant. The theoretical and experimental data are compared for the range of flow rates tested. Author

N65-33910# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.

NON-SIMILAR BOUNDARY LAYER HEAT TRANSFER OF A ROTATING CONE IN FORCED FLOW

J. C. Y. Koh and J. F. Price Apr. 1965 31 p refs
(D1-82-0433; AD-618482)

The non-similar boundary layer flow and heat transfer of a cone rotating in a forced flow field are investigated. Numerical solutions are shown for a half-cone angle of 53.5° with parameters $\left(\frac{v_w}{u_e}\right)^2$ ranging from 0 to 20, and with Prandtl numbers from .2 to 10. With a half cone angle of 90° (so that one has a rotating disk) the degenerate problem is solved in the same manner. Author

N65-33912# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

INTERFEROMETER STUDY OF NATURAL CONVECTION INSIDE A HORIZONTAL CYLINDRICAL CAVITY

Richard Irwin Erb (M.S. Thesis) Mar. 1965 49 p refs
(GAM-65A/ME/65-3; AD-618023)

An optical interferometer was used to observe the isotherms which developed within a horizontal fiberglass cylinder as it was non-uniformly heated in axial strips to a maximum wall temperature of 200 F. It was found that when single strips were heated separately, the local heat transfer coefficients at the cylinder wall adjacent to each heater reached a maximum value in the region 20° to 25° below where the wall surface was vertical. Also, the magnitude of the coefficients increased with time for about the first six minutes of heating and then decreased slightly. Numerous photographs are included which show the isothermal patterns formed when various segments of the cylinder wall were heated. Author

N65-33954*# National Aeronautics and Space Administration, Washington, D. C.

TEMPERATURE MEASUREMENTS WITH THERMOCOUPLES IN COMBUSTION GASES [TEMPERATURMESSUNGEN MIT THERMOELEMENTEN IN VERBRENNUNGSGASEN]

W. Alvermann and P. Stottmann Sep. 1965 34 p refs Transl. into ENGLISH of Res. Rept. 64-18, Deut. Forschungsanstalt für Luft- und Raumfahrt (West Germany) 1964
(NASA-TT-F-9537) CFSTI: HC $2.00/MF $0.50 CSCL 21B

For temperature measurements in combustion gases by means of thermocouples, corrections are suggested for compensating the errors due to the velocity of the medium, radiation, and heat conduction. The possible errors by catalytic effects when using thermocouples of noble metals are studied. Experimental results for different probes show that the corrected values are in good agreement. A method is described for electrically eliminating the radiation error by a resistance heating. The data corrections are tabulated, and the temperature data are plotted for various thermocouples. Author

N65-33973*# Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering.

TRANSIENT NATURAL CONVECTION FLOWS IN CLOSED CONTAINERS Technical Report No. 2

Hussein Zaky Barakat and John A. Clark Aug. 1965 234 p refs
Its Rept.-04268-10-T
(Contract NAS8-825)
(NASA-CR-64965) CFSTI: HC $6.00/MF $1.25 CSCL 20M

Studies on the phenomena of natural convection and thermal stratification in closed vessels with internal heat sources, as well as the application of finite-difference approximation techniques to find solutions for the governing differential equations, are reported. Considered were two-dimensional, transient, laminar free convections in partially filled rectangular and cylindrical containers, and the full two-dimensional energy and Navier–Stokes equations were applied. Examination of the observed stream line plots showed that the flow pattern is essentially the same for both types of containers. Calculations and measurements found that the formation of thermally stratified layers at the liquid surfaces were caused by either side wall heating, or by heat transfer across the interface, or by both, if the containers had an adiabatic fluid surface. In the absence of any side or bottom heating, the fluid temperature will be proportional to the surface temperature. Experimental measurements were in good agreement with the theoretical results, and it was concluded that the presented method of solution is applicable to any two-dimensional geometry. G.G.

N65-33987# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

CONVECTION AND RADIATION HEAT TRANSFER IN THE ENTRANCE REGION BETWEEN PARALLEL PLATES

William E. Mercer, III (M.S. Thesis) Jun. 1965 129 p refs
(GSP-65A/ME/65-2; AD-618027)

The effects of combined convection and radiation heat transfer for laminar flow between parallel plates are investigated, and an experimental study of the convection theory is made. The von Mises transformation is applied to the equations of motion and the convection energy equation; the equations are then written in finite difference form for numerical solution. For the combined heat transfer problem one plate is insulated and the other is maintained at a uniform temperature. The governing radiation equations are developed assuming black plates with the entrance and exit of the channel participating in the radiative energy exchange. Theoretical results are presented in tabular and graphic form. Author

N65-34034 ARO, Inc., Arnold Air Force Station, Tenn. Aerospace Environmental Facility.

THERMAL RADIATIVE PROPERTIES OF CARBON DIOXIDE CRYODEPOSITS

J. P. Dawson, B. A. Mc Cullough, B. E. Wood, and Richard Birkebak (Georgia Inst. of Tech.) *In* Arnold Eng. Develop. Center 6th Ann. Symp. on Space Environ. Simulation [1965] 18 p refs (See N65-34025 22-11)
(Contract AF 40(600)-1000)

Total reflectance and angular distribution of light reflected from carbon dioxide cryodeposits are measured in connection with a study of radiative characteristics of cryodeposits in the spectral range of 0.5 to 1.1 microns. Total reflectances were

determined in a 12-in diameter integrating sphere; distribution measurements, made in a 30-in diameter sphere, are presented as a function of cryodeposit thickness, formation rate of cryodeposit, substrate material, and angle of incidence of light beam. It is shown that substrate reflectance strongly influences total reflectance of a surface for thin layers of CO_2 cryodeposits. A reflectance plateau occurs that is essentially independent of the substrate, and the larger incident angles yield higher total reflectances. Thin layers of cryodeposits will greatly reduce the specular component of a reflecting surface. The angle of reflection of this component may deviate from the fundamental reflection law; the amount of deviation depends on the ratio of the incident radiation wavelength to the surface roughness. M.W.R.

N65-34053# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
EXPERIMENTAL STUDIES OF LOW-DENSITY EFFECTS IN HYPERSONIC WEDGE FLOWS
R. J. Vidal and J. A. Bartz Dec. 1964 35 p refs
(Contract AF 49(638)-952)
(CAL-AF-1500-A-2; AFOSR-65-0335; AD-616898)

Experimental heat transfer and pressure data are presented which extend from the classical thin boundary layer regime to near-free-molecule flow (Knudsen numbers based on ambient stream conditions as large as 5). These data are compared with viscous shock layer theory for heat transfer and with theory for the combined effects of wedge angle and boundary layer displacement to define the theoretical range of validity and to identify the low density departures from boundary layer theory. It is noted that low density effects are first evident in the pressure data. It is concluded that the cause of these departures cannot be identified within existing solutions based on the Navier–Stokes relations. It is hypothesized that the departures might stem from second-order (Burnett) molecular effects. Author

N65-34118# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AN INVESTIGATION OF BOILING WATER IN A POROUS MATERIAL AS A MEANS OF SEPARATING LIQUID AND VAPOR IN ZERO GRAVITY
Cecil Scott Boyd (M.S. Thesis) Mar. 1965 61 p refs
(GAM-65A/ME/65-1; AD-618022)

The study consisted of an investigation of boiling water electrically in a bed of aluminum particles as a means of separating liquid and vapor in zero gravity. Successful separation of liquid and vapor against gravity indicates similar success in zero gravity. Very small pressure drops (12 inches of water or less) were required to force the vapor against gravity. All flow rates tested were successful (11.6 gm/min to 78.6 gm/min) in producing both saturated and superheated vapor (204° F maximum superheat). Temperature probes indicated boiling occurred on aluminum particles near heaters and on heater surfaces. Conductivity of the bed was 12% that of solid aluminum. Author

N65-34128# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
A STUDY OF SYSTEM-INDUCED INSTABILITIES IN FORCED-CONVECTION FLOWS WITH SUBCOOLED BOILING
John S. Maulbetsch and Peter Griffith 15 Apr. 1965 158 p refs
(Contract AF 49(638)-1468)
(TR-5382-35; AD-619512)

A combined analytical and experimental program was carried out to investigate the problem of hydrodynamic stability of forced-convection flows with boiling. Two types of instability were recognized: The first, a nonrecurring excursive instability, and the second, an oscillatory instability in which the operating point varies in a sustained, repetitive way around the original condition. The excursive behavior was predicted on the basis of a comparison of the slopes of the pressure drop vs. flow rate curve of the heated section and the external system. The criterion for stability was simply that the slope of the external system characteristic be more strongly negative than that of the heated section. This was verified experimentally. This excursion was found to be the limiting condition on the heat flux in a parallel channel system. The oscillatory instability was investigated analytically through the use of a linearized, lumped parameter model in which steady-state measurements of the pressure drop were assumed to be valid in characterizing the transient characteristics of the heated section. Author

N65-34129# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
SURVEY AND EVALUATION OF TECHNIQUES TO AUGMENT CONVECTIVE HEAT TRANSFER
Arthur E. Bergles and Harmon L. Morton Feb. 1965 144 p refs
(Contract AF 49(638)-1468)
(TR-5382-34; AD-619511)

This report presents a survey and evaluation of the numerous techniques which have been shown to augment convective heat transfer. These techniques are: surface promoters, including roughness and treatment; displaced promoters, such as flow disturbers located away from the heat-transfer surface; vortex flows, including twisted-tape swirl generators; vibration of the heated surface or the fluid near the surface; electrostatic fields; and various types of fluid additives. Natural and forced convection situations for nonboiling, boiling, and condensation heat transfer are included. The conditions under which heat transfer is improved are summarized, and the efficiency of each technique is presented in terms of a performance criterion where possible. Author

N65-34169# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
RADIATION FROM AN ALTERNATING CURRENT NITROGEN ARC
P. W. Schreiber May 1965 81 p refs
(ARL-65-105; AD-620043)

An experimental investigation of the total power radiated per unit length from a nitrogen arc operating on alternating and direct current is outlined and sample results are given. In order to compare measured quantities with analytical calculations, an approximate solution of the single fluid time-dependent energy equation and Kirchhoff's voltage law was obtained. The solution is based on a simplified model of the arc column, and approximate equations are obtained for arc voltage, current, radius, temperature, and radiation in terms of the root mean square voltage gradient which remains as an unknown. The important parameters include line frequency and voltage, inductance, thermal diffusivity, and approximate slopes of electrical conductivity and radiant power per unit volume as a function of the heat conductivity potential. In general, measured results compare favorably with the analytical calculations based on the simple arc model. The measured radiation tends to be higher than calculated values if recent radiation data for nitrogen are used. However, the errors associated with the measured and calculated radiant power are too great to draw definite conclusions. Author

N65-34170# Marquardt Corp., Van Nuys, Calif.
TRANSPIRATION-FILM COOLING STUDY USING SPIRAL-WOUND-RIBBON NOZZLE Quarterly Progress Report No. 3, May 1–Jul. 31, 1965
J. E. Ahern, A. R. Nagy, Jr., and G. A. Yankura Aug. 1965 26 p refs
(Contract AF 04(611)-10387)
(Rept.-25173; AD-620007)

The design of the test nozzles was finalized based on the analytical studies, the analog results, and the laboratory bench test results. A preliminary evaluation of the effect of mass addition or nozzle performance was completed. Modifications to the spiral winding tool were completed and checked out satisfactorily. Grooving tools for variation of porosity in the test nozzles was completed and checked out. Author

N65-34187# United Aircraft Corp., East Hartford, Conn. Research Labs.
SCATTERING OF THERMAL ENERGY GAS BEAMS BY METALLIC SURFACES Final Report
John J. Hinchen and William M. Foley Aug. 1965 70 p refs
(Contract N600(19)-61950)
(D910245-7; AD-619714)

Modulated molecular beam techniques were employed to measure the spatial distribution of rare and atmospheric gases scattered from surfaces of polycrystalline platinum, tantalum, nickel, and tungsten. In some cases, molecular velocity changes which occurred during collisions between the beam and surface were determined through observations of shifts in the phase of the detector signals. Calculations were made of the influence of diffuse and lobular scattering on the lift and drag coefficients of flat plates in free-molecular flow. For more dense flows, the dependence of the extent of the slip flow region on the tangential momentum accommodation coefficient was evaluated. The aerodynamic implications of the scattering results are discussed. L.S.

N65-34243*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CHARTS OF ISENTROPIC EXPONENT AS A FUNCTION OF ENTHALPY FOR VARIOUS GASES IN EQUILIBRIUM
Leland H. Jorgensen Washington, NASA, 1965 13 p refs
(NASA-SP-3020) CFSTI: HC $1.00/MF $0.50 CSCL 20M

For enthalpies to 28 000 Btu/lb and pressures from 10^{-3} to 10^{2} atmospheres, curves of isentropic exponent as a function of enthalpy and speed are presented for equilibrium air, nitrogen, carbon dioxide, and a composition of 20-percent CO_2 and 80-percent N_2 (by volume). For a pressure of 1 atmosphere, curves are also presented for compositions of 10-percent CO_2–90-percent N_2 and 50-percent CO_2–50-percent N_2. Author

N65-34246*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL STUDY OF TEMPERATURE DISTRIBUTION IN LAMINAR FLOW OF A HEAT-GENERATING FLUIDS IN RECTANGULAR CHANNELS
Mary K. Strite and Robert M. Inman Washington, NASA, Oct. 1965
(NASA-TN-D-3039) CFSTI: HC $2.00/MF $0.50 CSCL 20M

An experimental investigation was conducted for laminar forced-convection flow of a heat-generating fluid in passages having rectangular cross sections. The results indicated that the wall temperature along the length of the ducts and the longitudinal variation of the difference between the local wall and fluid bulk temperatures can be predicted adequately from the theoretical analyses for the parallel-plate channel, provided the half-length of the short side of the rectangular duct is used as the characteristic dimension. The measurements also revealed that the hydraulic diameter concept, which implies that heat transfer in laminar flow in a noncircular passage can be calculated from, or correlated with, relations for a round tube by use of the hydraulic diameter, is not applicable for laminar heat transfer in rectangular ducts with heat sources in the fluid. The dimensionless thermal entrance length for the rectangular ducts was found to be a constant and independent of aspect ratio. Author

N65-34284# Virginia Univ., Charlottesville.
MIXING AND COMBUSTION OF A SUPERSONIC FUEL JET AND A SUBSONIC, COAXIAL GAS STREAM
John E. Scott, Jr. Aug. 1965 50 p refs Presented at the AIAA 2d Ann. Meeting, San Francisco, 26–29 Jul. 1965
(Contract Nonr-3623(00); Proj. Squid)
(UVA-7-P; AD-469052)

An experimental investigation of mixing and burning is described in which the progress of mixing and burning is followed by observing the spatial variation of static pressure in the mixing duct. Experiments showed that the duct length required for mixing and for mixing with simultaneous chemical reaction of the gaseous fuel jet are identical and are independent of the amount to be mixed and burned. In order to aid in the interpretation of the experimental data, the flow field is assumed to be "piecewise uniform" over the mixing duct cross section. The analytical variation of the static pressure in the mixing duct agrees in a semi-quantitative manner with the experimental data. The experimental and analytical results are combined to provide the spatial and temporal variation of the mixing parameter. It is found that the combustion process has the general effect of increasing the mean duct velocity which increases the turbulent exchange coefficient and, hence, increases the mixing rate. For the experimental geometry considered, the mixing and burning time is roughly half of the time required for mixing only and is independent of the energy released in the chemical reaction. Author

N65-34282# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
STAGNATION POINT HEAT TRANSFER IN AIR, CONSIDERING SIMULTANEOUS CHEMICAL REACTIONS
W. S. Rigdon and M. Thomas Sep. 1963 52 p refs
(SM-45730; AD-464586)

Presented is a theoretical analysis which was designed to test the validity of previous assumptions used in calculating heat transfer rates at the stagnation point of an atmosphere-entry vehicle. Investigated was the validity of assumed isolated chemical reactions used in calculating the transport properties of air. Considered in the analysis were dissociation and ionization reactions. It was found that the relative importance of this approximation becomes greater as more extreme entry conditions are considered. For super-satellite entry, the error introduced as a result of this approximation was calculated to be as much as 40%. Stagnation point heat transfer rates were calculated. Agreement between results and those obtained by previous investigations was observed at low pressures and/or flight velocities below 30 000 ft/sec. At pressures above one atmosphere and higher flight velocities stagnation point heat transfer rates obtained were as much as 40% greater than predicted. S.C.W.

N65-34305# General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.
HEAT TRANSFER IN PARALLEL ROD ARRAYS

W. A. Sutherland and W. M. Kays (Thesis, Stanford Univ.) Apr. 1965 72 p refs Prepared in cooperation with Stanford Univ. (Contract AT(04-3)-189)
(GEAP-4637) CFSTI: $5.00

The general problem of heat transfer in parallel rod arrays is considered. To accommodate the complexity introduced by this configuration, a method of analysis is developed using the technique of superposition of fundamental solutions. Fundamental solutions are determined experimentally which may be used to predict heat transfer accurately in parallel rod arrays of various spacings and with arbitrary power distribution from rod to rod. Predictions made for uniform and nonuniform power distributions are compared with measurements made of these conditions. The experimental investigation was conducted with air flow (Pr = 0.70) past electrically heated rods. The rod center-to-center spacing to rod diameter ratios of 1.15 and 1.25 were investigated for fully developed turbulent flow. Experimentally determined fundamental solutions are presented for Reynolds numbers of 7000 to 200 000. These results provide the engineering information necessary for design optimization of heat transfer in parallel rod arrays, and is the first step leading to a subsequent objective of developing higher performance configurations. Author

N65-34310# Aerojet-General Nucleonics, San Ramon, Calif.
ALKALI METALS EVALUATION PROGRAM: SWIRL FLOW BOILING OF ALKALI METALS HEAT TRANSFER AND PRESSURE DROP Topical Report
C. R. Fisher, J. H. Moskowitz, and L. T. Clark [1965] 57 p refs
(Contract AT(04-3)-368)
(AGN-8127)

Investigations were made of the heat transfer and pressure drop characteristics of rubidium, cesium and potassium boiling in a round tube in which a twisted metal ribbon was inserted to promote swirl flow. The experiments were performed in a columbium-1% zirconium alloy loop operated in an argon atmosphere at temperatures to 1850° F. Operating parameters were varied to obtain information useful to designers of boilers for space power systems. Stable pressure and flow conditions were achieved for most of the test runs. Data on nucleate boiling, liquid heating, and critical, or burnout, heat transfer are tabulated. A fog flow model is used to predict the critical heat flux, and reasonable agreement with the data is obtained. Pressure drop data are tabulated. A homogeneous flow correlation is found to give satisfactory agreement with the data. A comparison of the swirl flow data and axial flow results is presented. An appendix provides useful data on thermophysical properties of the fluids studied. Author

N65-34311# Allis-Chalmers Mfg. Co., Milwaukee, Wis. Atomic Energy Div.
PRIMARY SEPARATION OF STEAM FROM WATER BY NATURAL SEPARATION
John F. Wilson et al 15 Apr. 1965 44 p refs
(Contract AT(11-1)-1186)
(ACNP-65002; EURAEC-1389)

Accomplishments in moisture carry over tests, carry under in natural circulation systems, voids in a bubbling two-phase mixture, and an interface level detector in a program of natural primary separation of steam from water are presented. Tests were performed in a high pressure steam-water loop to determine the permissible steam release rates from a two-phase interface for various pressures and distances above the interface. An equation for predicting these release rates was developed. Air-water and steam-water tests, involving several geometry changes, were performed to study the void fractions in the downcomer region. High pressure steam-water tests were also performed to determine the void fractions in a bubbling two-phase mixture. As a conclusion to this test, an equation was developed to predict the void fractions in both flowing and nonflowing two-phase mixtures. A level detector for accurately locating the interface of a two-phase mixture, which operates on the principle of density difference, was also developed. C.T.C.

N65-34402*# Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.
CYCLIC HEAT FLOW THROUGH AN INSULATED TRIANGLE EXPOSED TO THE LUNAR ENVIRONMENT
Lawrence Conway and Thomas J. Kroupa, III May 1965 38 p refs
(Contract NAS8-20073)
(NASA-CR-67109; R-147) CFSTI: HC $2.00/MF $0.50 CSCL 20M

This report describes a thermodynamic analysis, numerical analysis and FORTRAN computer program which analyzes the periodic heat flow through a section of a body into the interior of the body. The section is triangular in shape and one side is exposed to the lunar environment while the other side is exposed to the body's interior environment. It is assumed that this results in a constant heat transfer coefficient. A profile through the section consists of a thin outer metal skin, any thickness of high grade insulation, and a thin inner metal skin. The computer program is listed in Brown Engineering Program Library as Program No. SP-149. Author

N65-34430*# Minnesota Univ., Minneapolis. Heat Transfer Lab.
THERMAL ANALYSIS OF ANODE AND CATHODE REGIMES IN AN ELECTRIC ARC COLUMN Quarterly Progress Report No. 9, Jul. 1–Sep. 30, 1965
E. Pfender, K. T. Shih, S. Wutzke, and E. R. G. Eckert 1 Oct. 1965 10 p
(Contract NAS3-2595)
(NASA-CR-54746) CFSTI: HC $1.00/MF $0.50 CSCL 20M

The investigation of heat transfer phenomena occurring in electrical arcs was continued, with work directed toward the complete design and construction of the arc tunnel modification. Preliminary tests with a cylindrical anode and without superimposed magnetic flux were conducted in the test section of the arc tunnel. A periodic voltage fluctuation was detected which could be traced to gas flow fluctuations caused by the transfer pump, with a frequency of approximately 50 cycles per second. The maximum amplitude of these voltage fluctuations was about one volt at a pressure of one atmosphere and rather high flow velocities. The flow fluctuations were in the range of ±8 percent. These values were measured by using a hot wire anemometer. Investigations in lower pressure ranges showed that the disturbance caused by the transfer pump is not so severe. R.R.D.

N65-34472# Air Force Systems Command, Wright-Patterson AFB, Ohio. Vehicle Equipment Div.
PERFORMANCE OF A SIMPLIFIED SPACE VEHICLE THERMAL CONTROL SYSTEM WITH A VARIABLE EFFECTIVENESS RADIATOR
Carl J. Feldmanis Jul. 1965 30 p ref
(AFFDL-(FDFE)-65-TM-33; AD-468235)

The general physical principles for room temperature superconductivity are evaluated. Density fluctuations of the mobile particles such as electrons make superconductivity impossible in one and two dimensions. The use of bound electrons instead of the ions to provide interaction can be effective

in long-wavelength situations, but their binding makes them ineffective for the short-wavelength interactions which are crucial for superconductivity. It was concluded that superconductivity at room temperature remains only a very remote possibility. G.G.

N65-34499# Columbia Univ., New York.
THERMODYNAMICS OF SOLUTIONS BASED ON A NEW MODEL OF BOND LENGTHS Final Report
Eugene S. Machlin Aug. 1965 6 p refs
(Grant DA-ARO(D)-31-124-G526)
(AROD-3278-5; AD-620057)

A new model of solid solutions was developed through the application of Bergman's model, for calculating elastic properties of metals, which is based on Pauling's empirical relationship between interatomic distance and bond number. The model developed clarifies the role of structure in the order-disorder transition and, therefore, removes the necessity for the Ising model to account for a first order transition in Cu–Au. The model is considered to have good predictive value when sufficiently good lattice parameter and elastic constant data are available; however, the model has limitations in cases where the physical phenomena intervene to make certain of the parameters composition dependent; also, it is too simple in that it assumes a non-variant lattice parameter. The model emphasizes the value of accurate elastic constant data for both elements and ordered alloys. The extension of Bergman's model to superlattices is suggested, as is the extension of the solid solution model to body-centered cubic and hexagonal structures and to partially-ordered solutions. M.W.R.

N65-34540# Army Materials Research Agency, Watertown, Mass. Materials Engineering Div.
BLACKBODY REFERENCE FOR TEMPERATURES ABOVE 1200 K: STUDY FOR DESIGN REQUIREMENTS
Albert F. Grenis and Michael J. Matkovick Jan. 1965 22 p refs
(AMRA-TR-65-02; AD-614638)

Studies were made in the design of a temperature reference unit, incorporating a vacuum system with a sighting window, for temperatures, ranging from 1200 K to 2100 K. In view of the many variables present, the design study was supplemented with analytical and experimental data. Included in this work were transmittance studies of different sighting windows for blackbody radiation, the study of thermal shielding, and experimental studies of blackbody radiation. The window materials available included fused silica, calcium fluoride, and sodium chloride. Recommendations are made in regard to structural materials, sighting windows, and thermal shielding. Author

N65-34637 Aerodynamische Versuchsanstalt, Gottingen (West Germany).
HEAT TRANSFER AND TEMPERATURE DISTRIBUTION IN TURBULENT BOUNDARY LAYERS AT SUPERSONIC AND HYPERSONIC FLOW
J. C. Rotta *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 35–63 refs (See N65-34635 22-12)

Theories to predict the rate of heat transfer and temperature distribution are reviewed. On the basis of these considerations, available experimental data are compared and turbulent Prandtl numbers are calculated from the experimental survey data. As far as turbulent boundary layers with zero heat transfer are concerned, the temperature distributions are in good agreement with predictions from Crocco's relation, and the integral of total energy is satisfied with a reasonable degree of accuracy. The turbulent Prandtl numbers are found in agreement with observations at subsonic and incompressible flow tests. When boundary layers with heat transfer are considered, remarkable differences are observed between boundary layers on nozzle walls and on a flat plate. The turbulent Prandtl numbers indicate extremely low turbulent heat transport rates in proximity of the wall when compared with the momentum transport. No evidence can be furnished that the Crocco relation provides a satisfactory approximation to the temperature distribution in supersonic turbulent boundary layers with heat transfer. Author

N65-34649 Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany).
HEAT TRANSFER IN LAMINAR BOUNDARY LAYERS WITH OSCILLATING OUTER FLOW
K. Gersten *In* AGARD Recent Develop. in Boundary Layer Res., Pt. I May 1965 p 423–475 refs (See N65-34635 22-12)
(Contract AF 33(615)-1263)

Presented is a detailed analysis of a class of laminar two-dimensional time-dependent velocity and thermal boundary layers whose free-stream velocity is given by

$$U(x,t) = cx^m(1 + \epsilon \cos\omega t),$$

where ϵ is a small disturbance parameter. The solutions were expanded into power series of the disturbance parameter. The equations for the first and second-order terms have been solved for small values of the frequency ω as well as for large frequency values. These two solutions for low and high frequencies can be matched at intermediate frequencies. The solutions show that the velocity and temperature in the different layers of the boundary layer acquire oscillations which experience phase shifts with respect to the forcing disturbance and to each other. Due to the non-linear terms in the flow equations the fundamental oscillation induces higher harmonics in the boundary layer oscillation and a steady-state part, which is responsible for the alteration of the mean values of skin-friction and heat transfer coefficient by the outer flow oscillation. Numerical results for the flow along a flat plate and for stagnation point flow are given. Author

N65-34659 Centre National de la Récherche Scientifique, Meudon (France). Laboratoire d'Aérothermique.
HEAT AND MASS TRANSFER ON SWEPTBACK CIRCULAR CYLINDERS IN A SUPERSONIC FLOW [TRANSPORT DE CHALEUR ET DE MASSE SUR DES CYLINDRES CIRCULAIRES EN FLECHE DANS UN ECOULEMENT SUPERSONIQUE]
E. A. Brun, G.-B. Diep, and B. le Fur *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 715–753 refs In FRENCH; ENGLISH summary (See N65-34653 22-12)

This paper presents the main data obtained from a comprehensive study of heat and mass transfer from sweptback circular cylinders in a Mach 2.42 wind tunnel, the Reynolds number referred to cylinder diameter being 100000. As regards heat transfer, comparison with theories for infinite cylinders shows good agreement for a laminar or turbulent boundary layer. The mass transfer investigated was naphthalene sublimation. The analogy between Sherwood and Nusselt numbers was verified except for the cylinder without sweepback, where significant erosion occurs at very high Sherwood numbers. Also, on the sublimated cylinders, there were grooves produced by vortices directed along the stream lines, in the laminar as well as in the turbulent boundary layer. Author

N65-34663 Toronto Univ. (Ontario). Dept. of Mechanical Engineering.
INNER AND OUTER LAW DESCRIPTIONS OF TEMPERATURE AND VELOCITY IN TWO AND THREE DIMENSIONAL BOUNDARY LAYERS
E. Brundrett, W. D. Baines, J. Peregrym, and P. R. Burroughs *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 855–880 refs (See N65-34653 22-12)

Temperature and velocity measurements have been performed for incompressible air flow with moderate heat transfer rates, for turbulent flow over a plate, and in a square duct. Close to the wall both velocity and temperature profiles are correlated by the inner law formulation. Local values of shear stress and heat transfer must be used for consistent results in every configuration. In the region adjoining the external flow the outer law provides a good description for the velocity and nmperature profiles in the boundary layer of a flat plate. A skgle parameter outer law formulation is not possible for the square duct because secondary motions distort the primary flow. The inner and outer law correlations for the velocity and temperature profiles in the boundary layer of a flat plate. A single parameter outer law formulation is not possible for the The relationship was extended to include pipe and non-circular duct flow. Author

N65-34664 Aix-Marseilles Univ. (France). Institut de Mecaniques des Fluides.
EXPERIMENTAL AND THEORETICAL RESULTS ON HEAT TRANSFER AT THE LEADING EDGE OF HYPERSONIC SWEPTBACK WINGS [RESULTATS EXPERIMENTAUX ET THEORIQUES SUR LE TRANSFERT DE CHALEUR AU BORD D'ATTAQUE DES AILES A FORTE FLECHE EN HYPERSONIQUE]
J. Valensi, R. Michel, and D. Guffroy *In* AGARD Recent Develop. in Boundary Layer Res., Pt. 2 May 1965 p 881–907 refs In FRENCH; ENGLISH summary (See N65-34653 22-12)

This paper is devoted to a survey of the theoretical and experimental results on laminar heat transfer at the leading-edge of hypersonic wings. The results of pressure and transfer heat rate measurements at the stagnation line of leading-edges at Mach numbers 4, 7 and 10 are presented. Two techniques of theoretical analysis are described and illustrated; they are based on the solution of the local and global boundary layer equations respectively. The theoretical and experimental results are in satisfactory agreement in the case of large sweep angle but the effect of a strong entropy gradient due to the curvature of the shock-wave is evident in the case of medium sweep at high speed. Author

N65-34691# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
STUDY OF HEAT TRANSFER FROM A HEATED CYLINDER IN TWO-PHASE, WATER-AIR FLOW
James F. Hoelscher (M.S. Thesis) Mar. 1965 55 p refs
(GAM-65A/ME/65-5; AD-618024)

The purpose of this study was to obtain experimental data on the effect of the water-to-air mass flow ratio in a horizontal, two-phase, air-water flow on the overall film heat transfer coefficient on a vertical cylinder, and to determine the variation of the local film heat transfer coefficient on a vertical cylinder, in a horizontal, two-phase air-water flow. A suitable apparatus was constructed; it consisted of a heated cylinder, a wind tunnel, nozzles, and temperature, power and pressure monitoring equipment. The two-phase flow was formed by spraying water into the wind tunnel air flow. It was found that introduction of water droplets into the airstream sharply increased the overall film heat transfer coefficient; and, after a water-to-air flow ratio of about 0.04, the heat transfer rate varied only slightly with increases in water-to-air ratio. At the peak condition noted in the study, overall film heat transfer coefficient was increased by a factor of 8.5 by the introduction of water into the airstream. Author

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N65-33683# New York Univ., N. Y. Research Div.
COMMERCIAL FREQUENCY COUNTERS AND TIMERS
Henry S. Lax Apr. 1964 30 p
(Contract NObsr-89288; Proj. Sete)
(SETE-210/73; AD-460861)

Lists are presented of the essential measurement functions of counters and timers commercially available, as well as some of their characteristics. These include range, input, dimensions, and price. The tabulations do not show the versatility of many of the instruments listed because their ranges and sensitivities can often be extended by optional plug-in units. It is noted that the refinement and usefulness of an instrument is usually reflected in its price. R.R.D.

N65-33694# Physics International Co., San Leandro, Calif.
EXPLOSIVE GAS GUN Third Quarterly Progress Report, Jan. 1–Mar. 31, 1965
Charles S. Godfrey 15 Apr. 1965 9 p
(Contract DA-04-200-AMC-796(X); ARPA Order 546)
(PRQ-024-3; AD-464659)

Continued research conducted under a program designed to develop an explosive gas gun capable of accelerating 5- to 10-lb projectiles to velocities of 20 000 ft/sec, is reported. To maintain the integrity of the projectile, major emphasis was focused on tailoring the pressure profile which the gas exerted upon it. Presented are results of experiments on small scale systems in which concrete and steel tamping were used. Use of concrete tamping resulted in scattered damage being inflicted upon the target which demonstrated that the projectile was not launched intact. The use of steel tamping resulted in an unbroken projectile. Also reported are studies of methods of accelerating relatively small projectiles (~0.1 g) to very high velocities (~100 000 ft/sec). One of the shots utilized a reservoir concept in which the part of the barrel containing the projectile was of smaller diameter than the part in which the piston was driven. An area ratio of 1:4 was chosen. The shot resulted in a projectile velocity of about 22 000 ft/sec with the projectile remaining intact. S.C.W.

N65-34075# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME I, NO. 9 A Monthly Review of Selected Foreign Scientific and Technical Literature
Sep. 1965 91 p refs

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N65-34082 Library of Congress, Washington, D. C. Aerospace Technology Div.

SOVIET HYDROFOILS

Gerhard Erleman *In its* Foreign Sci. Bull., v. 1, No. 9 Sep. 1965 p 67–72 refs (See N65-34075 22-34)

A review of Soviet publications dealing with cavitation and the foil's angle of attack in a time-dependent relationship, materials, and structures is presented. The multiplicity of publications on hydrofoil subjects, and the rapid expansion of the us of hydrofoil craft for passenger service is felt to demonstrate Soviet belief in the practicability of this transportation method. The observation is offered that Soviet concern with the cavitation inception on the lower surface of the subcavitating foil implies the use of much higher camber foils than is common. M.G.J.

N65-34093# Naval Ordnance Lab., Corona, Calif.

FOUNDATIONAL RESEARCH PROJECTS Quarterly Report, Jan.–Mar. 1965

1 Jun. 1965 78 p refs

(NAVWEPS-8812; AD-616894)

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7. SOLID STATE SPECTROSCOPY. ENERGY LEVELS OF Pr^{3+} IN LaF_3 H. H. Caspers, H. E. Rast, and R. A. Buchanan p 59–78 refs (See N65-34100[3] 22-06)

N65-34191# Joint Publications Research Service, Washington, D. C.

RAPID DEVELOPMENT OF MINIATURE-TYPE ELECTRONICS Translations of Communist China's Science and Technology No. 219

28 Sep. 1965 22 p refs Transl. into ENGLISH from K'o-hsueh T'ung-pao (Peking), 20 Jul. 1965 p 601–609 (JPRS-32171; TT-65-32664) CFSTI: $3.00

Presented is a review of the technological development of miniaturized electronic equipment and components. Included is a discussion of developmental progress in combined-, thin film-, solid-, and molecular-circuitry; basic techniques as the thin film- and crystal growth-techniques which were essential to the working accuracy of miniaturized circuits; and suggested areas of research essential to the future development of miniaturized electronics. S.C.W.

N65-34192# Joint Publications Research Service, Washington, D. C.

TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY No. 220

29 Sep. 1965 27 p refs Transl. into ENGLISH from Ts'e-Liang Chi Ti-Ch'iu Wu-Li Chi-K'an (Peking), no. 1, Feb. 1965 p 96–112

(JPRS-32185; TT-65-32676) CFSTI: $2.00

A review of the principles and development of the laser is presented. The use of lasers for the measurement of distance, angle, height, and geodetic surveying is also proposed. It was pointed out that in planning for laser application in survey work, the control, filtering, receiving, converting, and indicating systems must be adapted, and the effect of dense atmosphere on laser beams better understood. W.M.R.

N65-34327# Rensselaer Polytechnic Inst., Troy, N. Y.

HIGH SPEED MASS TRANSPORTATION: A NEW CONCEPT

S. V. Foa et al Jul. 1965 184 p refs Sponsored in part by Ford Foundation

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N65-34548# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

[GENERAL PHYSICS, PLASMA DYNAMICS, AND COMMUNICATION SCIENCES AND ENGINEERING] Quarterly Progress Report

H. J. Zimmerman and G. G. Harvey 15 Jul. 1965 307 p refs (Grants NsG-496; NSF GK-57; Contracts AT(30–1)-1842; AF 33(615)-1083; DA-36-039-AMC-03200(E))

(QPR-78; AD-620083)

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